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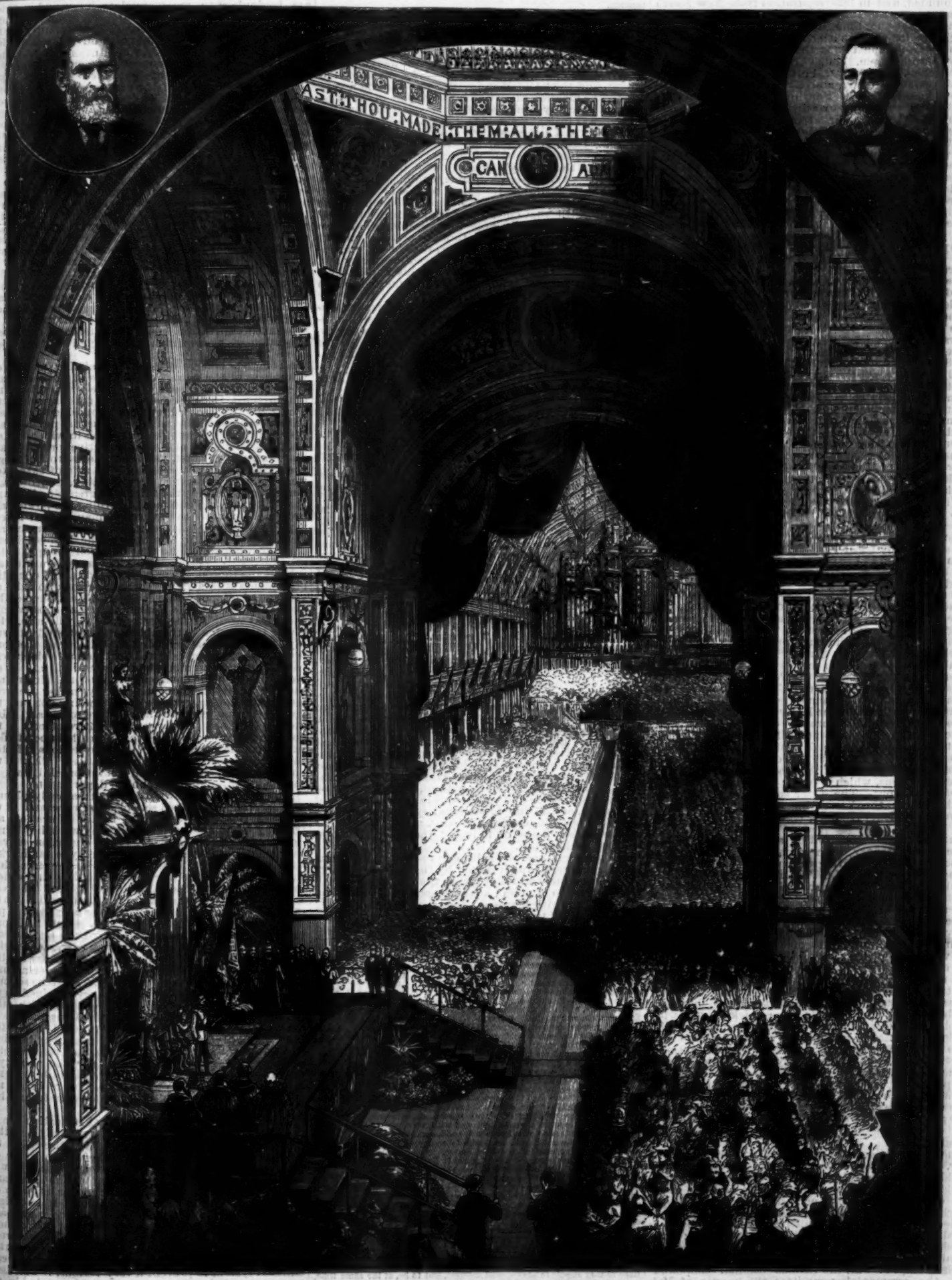


THE MELBOURNE CENTENNIAL INTERNATIONAL EXHIBITION—THE OPENING CEREMONY.

OPENING OF THE MELBOURNE EXHIBITION.

IT was one hundred years ago that the great island which Torres called "Terra Australis," and which Flinders afterward shortened to "Australia," was taken possession of by Captain Cook for the British crown. He cast anchor in Botany Bay, a few miles to the southward of Sydney Harbor. Previously to this, Dampier, Tasman, Carpenter, and others had examined the coasts. The history of the Australian colonies begins with the landing of the first shipload of convicts at Botany Bay, in 1788, under the command of Captain Phillip. In 1795 Governor Hunter formed settlements on the Hawkesbury. During Governor King's term of office, about 1803, Macarthur started wool growing at Camden, with a couple of Spanish merino sheep, given him by George III. In 1803 a settlement was formed in Tasmania by Judge-Advocate Collins. Hobart Town was founded, and in 1829 separation from New South Wales was effected. In 1815 Governor Macquarie built a road across the Blue Mountains, and thus opened a highway for the squatters. The first quarter of a century was occupied with the inland explorations of Oxley, Cunningham, Hume, Hovell, Sturt, Macleay, and Mitchell. But in 1802, Port Phillip was discovered by Lieutenant Murray, and Mr. Charles Grimes, Surveyor-General of New South Wales, entering Port Phillip on a surveying expedition, sailed up the river Yarra. This was the first trip, probably, made by a white man. It appears, from the records available, that thirty-two years elapsed before the second white man went on a similar trip. The first attempt at settlement was made by the Hentys, of Launceston, Tasmania, who, in 1834, established a whaling station at Portland Bay. In the year following, John Batman formed a settlement on the western shore of Port Phillip; and Melbourne practically commenced its existence from that date. In 1851, the Port Phillip district was merged in the newly constituted separate colony of Victoria, and Mr. C. J. Latrobe, who had been superintendent of the district, became the first governor.

The territory of Victoria extends from the 34th to the 39th deg. of south latitude and from 141 deg. to 150 deg. east longitude. It is separated from New South Wales by the river Murray and by a line from Forest Hill to Cape Howe, while the 141st meridian of longitude separates it from South Australia on the southwest. Its extreme length is 480 miles, its breadth 240, and its area 97,884 square miles, or 56,245,760 acres. The territorial divisions consist of four districts and thirty-seven counties. Gipps Land is characterized by colossal mountains, chiefly of volcanic formation, magnificent streams, and fertile plains. The Murray district is also mountainous, and well watered; some parts are noted for auriferous wealth, others are adapted to agriculture; in the northeast are extensive pastoral plains. Wimmera district, covering about 25,000 square miles of the northwest of the colony, and Loddon district, occupying the north central portions, are chiefly adapted to pastoral pursuits. The climate of Victoria is generally healthy and pleasant. Victoria had a population of 1,003,043 at the census of 1886.

The city of Melbourne, which was incorporated in 1842, stands on the north bank of the river Yarra, six or seven miles from the sea at Hobson's Bay. It is encircled by populous suburbs—some of them, indeed, are called cities—the number of inhabitants ranging from 5,000 to 26,000. The total population of Melbourne and the suburbs is estimated at 371,630. The city streets, aggregating 100 miles in length, are straight and run at right angles through the entire length and breadth of the town. The main thoroughfares are Collins Street, Bourke Street, Flinders Street, Swanston Street, and Elizabeth Street, all with cable tramways. The most important public edifices are the Parliament Houses, the Treasury, the Law Courts, the University, the Public Library, the National Museum, the Town Hall, the Mint, and the two cathedrals, the latter not being completed. Some of the banks, insurance companies, and wool brokers occupy magnificent buildings, bluestone and freestone being the material mostly used. The governor's residence, on the south side of the Yarra, is a large mansion, occupying one of the most elevated sites. The Botanic Gardens, which have an area of 100 acres, are tastefully laid out. The water supply of Melbourne is obtained from the Yan Yean reservoir, in a valley among the Plenty Ranges, eighteen miles from the city.

The international exhibition at Melbourne to celebrate the centenary of the Australian colonies was opened on August 1 with great ceremony, by Sir Henry Brougham Loch, G.C.M.G., K.C.B., the governor. His Excellency, with Lady Loch and a number of their guests, entered the city by way of New Prince's Bridge, under a salute from the batteries. An immense procession was formed, and accompanied the governor's party to the exhibition buildings, marching through Collins Street and other thoroughfares. The procession was headed by a number of seamen, marines, and men of the naval brigade, followed by rifles, artillery men, and militia. Then came the fire brigades and trades and friendly societies, which had mustered several thousands strong, with banners flying and bands playing. The streets were thickly lined with people, who displayed great enthusiasm; and the whole route presented a brilliant appearance, the windows being crowded with spectators, who cheered heartily, and the houses profusely decorated with flags.

The specially invited guests, to the number of 7,000, had previously assembled inside the exhibition building, at the entrance of which a guard of honor, with colors, were drawn up. The Grand Avenue of Nations, 1,350 yards long, was lined with troops, while the seamen of the imperial fleet were drawn up round the grand hall.

The governor entered the exhibition by the north door, where he was received by Sir J. MacBain, the president, the Hon. F. T. Sargood, the executive vice-president, the executive commissioners, and the members of the ministry, his arrival being heralded by a flourish of trumpets. His Excellency was then conducted to the dais by the distinguished persons present, the procession being in the following order: The marshal of ceremonies, the deputy marshals, the imperial naval and military officers, the officers of the foreign ships of war, the various colonial commandants, the ceremonial committee, the mayor of Melbourne, the colonial judge, the executive commissioners and the secretary, the members of the Australian cabinets, the colonial chief justices, the speakers of the various legislative assemblies, the Hon. Duncan Gillies, the Victorian premier; Sir W. Foster Stawell, the lieutenant-governor of Victoria; the Hon. F. T. Sargood, the executive vice-president; Sir J. MacBain, the president of the exhibition; Admiral Fairfax, commander on the Australian station; the aides de camp of the governor; the governor, with Lady Loch and family; the other governors and their wives; the presidents and vice-presidents of the colonial courts, and the foreign consuls and commissioners. The governors of Australasian colonies present, besides Sir Henry Loch, were Lord Carington, governor of New South Wales; Sir W. F. Drummond Jervois, governor of New Zealand; Sir Anthony Musgrave, governor of Queensland; Sir W. C. F. Robinson, governor of South Australia; and Sir Robert Hamilton, governor of Tasmania.

As the procession passed up the Grand Avenue of Nations, the national anthems of America, Germany, Austria, and France were played by bands stationed in each of the courts named, and when the grand hall was reached the British national anthem was sung, Mr. F. H. Cowen conducting. The president then offered prayer, and the "Old Hundredth" was sung in a very impressive manner, after which the "Song of Thanksgiving," specially composed for the occasion by Mr. Cowen, was brilliantly rendered by an orchestra of 100 performers and a chorus of 800 voices.

Sir J. MacBain read an address to his Excellency, welcoming him to the exhibition and conveying an assurance of the colony's loyalty. The president then thanked the various governments, exhibitors, and peoples for their flattering responses to the invitation to participate in the exhibition, and after presenting the governor with the official catalogue, concluded his speech by expressing the hope that the inspection of so many products of the world's thought and labor might educate the people to higher enterprises in art and industry in the future, to the enhanced prosperity and happiness of all. He then handed to his Excellency a beautifully wrought golden key, and requested him to declare the exhibition open.

At the conclusion of the ceremony, the governor dispatched a telegram to the Queen informing her Majesty that the exhibition was open. A telegram was also sent to the Prince of Wales. The arrangements for the ceremony are much commended. There was an immense attendance at the exhibition.

The above particulars are from the *Illustrated London News*, and our engraving is from the *Graphic*.

NOTES ON TECHNICAL EDUCATION.*

By Dr. ROBERT H. THURSTON.

THE REASON AND PURPOSE OF TECHNICAL EDUCATION.

THE prosperity of the people of any country is dependent, primarily, upon their own industry and integrity, skill and enterprise, persistence and "pluck," and, to a considerable extent, upon the natural advantages and resources of the country itself, as determined by the character of soil and climate, and upon the location with respect to home and foreign markets and sources of supply of raw material; but the prosperity of a nation is the greater, other things being equal, as the value of the labor of the working classes is increased, and the value of such labor is the greater as the products of industry are more generally the result of trained skill, and cultivated taste and talent, employed in the so-called skilled industries. The cultivation and diversification of skilled industries, of the mechanical arts, and of art industries, is evidently mainly to be relied upon to promote the highest possible prosperity of a people. Trade education, schools of the mechanic arts and of engineering, the cultivation of industrial art, the promotion of the fine arts, in such manner as to give to the worker the intelligence and skill needed to enable him to do good work, and to provide new and broadening fields of labor, free from the fatal competition that causes each laborer to become the enemy of his neighbor, are the resources upon which only we may rely for the relief of the pressure characterizing modern civilization. Those states, and those nations, will evidently be the most successful and prosperous in which the aim of legislation, and of the educational system, is to secure the effective training of the laborer, and to the worker in the higher fields of industry the most thorough training for his work.

The accumulation of wealth can result only from our material progress, and it is only by the accumulation of wealth that the world may secure the blessings of intellectual, or even of moral, advancement, the comforts of life, and healthful luxuries. But the accumulation of wealth comes of the two lines of progress: the cheapening of all essential and destructible elements of life and civilization and the steady and efficient application of the powers of the body and of the intellect of man to the production of permanent and essential wealth in the forms most useful to the mass of mankind. The highest duties of the state and the citizen are thus to be fulfilled by providing the opportunity to every man to give his sons and his daughters the means of making their heads and their hands of maximum service to themselves and to their neighbors, to gain means of directing the forces of nature, and the power of utilizing their own natural ability and skill with highest efficiency. Education must be directed in such manner as to give, in the least possible time and in the most effective way, at least a preparation for the duties of daily life, while, at the same time, so far as is practicable without interference with the more imperative work, training the scholar to become a good citizen, and to enjoy the intellectual side of existence.

It is in recognition of this view of our duties that we are beginning to see manual training and a trade school system incorporated into the common school system of education of every civilized country, and technical and professional schools and colleges taking their place beside the older institutions of learning. From this time on, he who would accomplish most in either of the departments of skilled industry or in either of the branches of the great profession of engineering, must combine scientific attainments with experimental knowledge of facts and phenomena, mechanical ability, and good judgment and taste ripened by large experience in business and familiarity with the ways of the world. It is only when manual training and trade schools are found in every town, technical schools in every city, and colleges of science and art in every State, so united in a system that shall insure to every one the privilege of learning the scientific basis of any art, and of laboring in every or any branch of industry, as to make certain a recompense for all the zeal, intelligence, skill, and industry that the worker may exhibit, that the professions will attain their grandest development, science and art find closest and most fruitful union, and that the citizen may enjoy to the fullest extent all that he may rightfully demand in his pursuit of all that life and liberty can offer him and the most perfect happiness that can come to man. The highest skill, the most reliable labor and the most admirable artistic talent are to be obtained only by systematic cultivation, and the new features of modern education are those which are directed to the object above outlined.

A complete scheme of education aiming at the development of the powers of the mass of the people and the securing of the greatest possible prosperity of the nation must include the manual training school for youth, the trade school for those proposing to fit themselves for successfully pursuing industrial pursuits, and the technical and engineering schools in which the scientific development of the constructive professions is aimed at. In the first, young people are to be taught the use of tools; in the second, the arts of carpentry, weaving, blacksmithing, stone cutting, and other industrial arts; and in the third, the greatest of all arts, that of contriving methods of turning the powers and processes of nature to the uses of man, and of inventing and designing all the mechanism, apparatus, and structures needed in the work. The highest department of instruction, and that in which the greatest of all the institutions included in the system will take part, is the thoroughly scientific training and education of students with a view to preparing them to take advantage of all new discoveries and inventions, to thus keep themselves in the front rank among those who do the great work of the profession; it will also, while giving instruction to the ablest and best students, supply to the technical schools and colleges of the country well taught and talented instructors, able investigators, and skillful administrators, and will aid by scientific research the development of every industry, and furnish a nucleus about which may gather the great men of the nation, capable of instructing not only the youth who may come to their lecture rooms and laboratories, but the legislators and executive officers of the government whenever they may be called upon to deal with any one of the innumerable questions affecting the national weal through its industries. This is the position which it is desired that Cornell University shall take, through her technical departments.

Experience has shown that systematically planned and carefully conducted schools of science and of the arts are vastly more efficient in the education and training of young people than any workshop or mill can possibly be. In them, every operation may be thoroughly taught and the learner may be familiarized with every detail without loss of time or strength on the part of either teacher or pupil. It is such a system, incorporated into the educational scheme of every European country, that has given them, notably in the case of France and Germany, such rapid growth in productive power and prosperity, and which has, for a time, threatened other nations with such serious competition. It is now recognized as an obvious principle that, in order that a nation may prosper under existing conditions of competition and cheap transportation of materials and products, the people must be so much better educated in the principles, and trained in the practice, of the arts in which they compete with other nations that their marketable productions may be introduced into the markets of the world, competing both in quality and price with all that may be there encountered, and yet the producers may receive better remuneration for the day's work by their ability to make a day's work more productive through the exhibition of greater skill, or the invention of better machinery, and by the exhibition of finer taste and better knowledge of art.

The modern systems of technical education are directed toward these vitally important ends, and it is perfectly evident to every intelligent citizen that the prosperity of the nation is, for the future, to be dependent mainly upon the success and rapidity with which this system is introduced throughout the land. Where there is to-day one such school as has been described, a hundred are already needed. It is difficult to realize the rate at which foreign nations are advancing in this direction, and how rapidly our own country is being distanced. It will demand the most earnest thought and the most energetic action on the part of those entrusted with the work of developing our educational system to prevent a very serious, if not disastrous, competition from abroad, within, probably, the

* It is now just three years since the Sibley College of Mechanic Arts of Cornell University was reconstructed by the trustees of that progressive institution and made a school of mechanical engineering. The University is working under a charter founded upon the act of Congress giving the State of New York about a million acres of land for the purpose of promoting the useful arts by the establishment of a college having that purpose as its principal object. This charter has been in operation now twenty years, and the endowment secured by sale of lands located by Ezra Cornell, and carefully marketed by him and by the trustees of the University, who assumed his obligations, and aided by the gift in cash from Mr. Cornell of a half million dollars, has gradually become capable of providing instruction for a thousand university students. Of these about one-half are engaged in studies of a technical and professional character; while the others are pursuing academic courses. Sibley College, beginning in a very humble way, has grown to a large institution in itself, and now contains about one-fourth of all the students in the University. It began as a school of the mechanic arts, and in the earlier years of its existence had few students and very few graduates. The reorganization in 1885, by the addition of a department of mechanical engineering and the reducing of all its related departments to a single systematic whole under a single head, and with very considerable accessions of apparatus and tools, led to very sudden and somewhat embarrassing growth, while making it, as it stands to-day, the largest school of mechanical engineering in the United States.

The headship of the college was intrusted to Dr. R. H. Thurston, who was made "director," and to whom the details of organization and the planning of the courses of instruction was confided, subject to the approval of the authorities of the University. The study of the problem thus presented, and the experience gained in the endeavor to carry into effect the general views and plans of the trustees, as originally outlined to the director by them, through the president of the University, has led to the formulation of somewhat definite principles and plans, and these have been from time to time, under the original instructions, laid before the governing body in a series of reports, not intended for publication. They contain much material, nevertheless, that may, we think, be placed before our readers with propriety and with profit, if we may judge by the matter already furnished us by their author, who has agreed to abstract for the *Academy* such portions as may appear to have special interest, and to be, at the same time, available for public use.—*Editor of the Academy.*

next generation. It is fortunate that the change has progressed in our own country even so far as it now has, and that its continued progress is assured.

But science and technical studies will never, and should never, displace the older departments of education. As the one is needed for the material welfare of the country, the other is essential to its intellectual prosperity and to the cultivation of the real scholarly spirit and to the growth of the æsthetic side of life, of all that makes the possession of wealth really desirable.

When the new system shall have become fully developed, it may be hoped and fully expected that it will be common, if not customary, among those who pursue science, and study the profession, engaged in construction, to secure, first, the broad and liberal culture of the older schools before entering upon their purely professional studies. It is this feature which Cornell University is especially well prepared to introduce and to encourage. Here the line of work will lead into and through the general courses and on into the professional schools. Knowledge, discipline, training in all the humanities, may, and should, precede the final special preparation for the special work chosen as the means of doing most for the world and of acquiring fortune.

European nations have been for many years, for a century at least, steadily, systematically, and intelligently, carrying out the policy above outlined, and the only way in which to compete with them is evidently to adopt a similar policy, with even greater care, and with, if possible, more effective methods. Technical and trade education have for so many years been a part of the French and German system of aiding manufacturers that we may expect it to require many years to equal, much more to distance, them in the race. The effect has long since been felt in the importation of skilled artisans and engineers from those countries, to do work demanding peculiar expertness coming of such scientific training. We have taken up our work in this direction none too early. It is a matter of congratulation that Cornell University was planned with a view to the effective promotion of the needed work. —*The Academy.*

GASHOLDERS WITHOUT UPPER GUIDE FRAMING.*

By THOMAS NEWBIGGING, of Manchester.

THE present paper is intended to describe a recent invention of Mr. William Gadd, of Manchester, whereby an entirely new principle is introduced, by the application of which a gasholder may be securely guided from the bottom curb; the whole of the elevated framing being done away with, while at the same time the strain of wind or snow pressure upon the holder has the effect of producing greater rigidity in the structure. How this is accomplished I will explain immediately.

The weight of the guide framing of gasholders, as usually designed and constructed, if composed of wrought iron standards, slightly exceeds that of the floating vessel; and if of cast iron columns, the weight of the framing is greater still. It follows, therefore, that the cost of the guide framing of a holder amounts to about one-half the cost of the complete structure.

I have various recent examples of gasholders and their guide framing, which I have put together in the form of a table, which may be quoted in support of this position.

Description.	Weight of Holder or Bell.	Weight of Tank Guide Framing.	Weight of Upper Guide Framing.	Total.
	Tons.	Tons.	Tons.	Tons.
Single-lift holder, 50 feet dia., 16 feet high	18	3	17	38
Do., 73 feet dia., 18 feet high	44	5	40	89
Do., 80 feet dia., 20 feet high	47	5	50	102
Do., 80 feet dia., 28 feet high	49	9	53	111
Two-lift telescopic holder, 80 feet dia. each lift 20 feet high	70	6	82	158
Do., 80 feet dia., each lift 20 feet high	61	7	70	138
Single-lift holder, 100 feet dia., 24 feet high	66	7	75	148
Two-lift telescopic holder, 120 feet dia., each lift 24 feet high	107	12	86	205

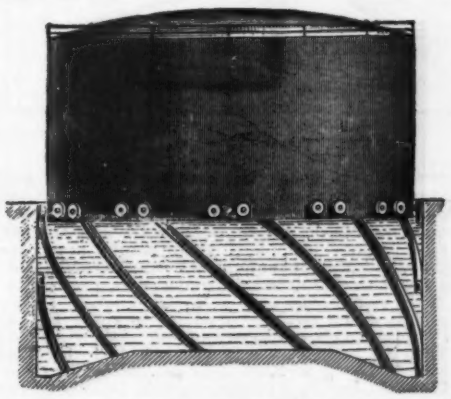
Now, such being the facts, it is evident that if the upper guide framing of a gasholder could be dispensed with altogether, and equal or greater stability and safety in the rise and fall of the floating vessel secured, a saving of about 50 per cent. would be effected in the cost of construction and erection. An attempt—and, as I believe, a successful attempt—to secure this condition of safety, while dispensing with the elevated framing of gasholders, has been made in Mr. Gadd's invention—two models of which I have the pleasure to submit. Like most important inventions, the means for attaining the end contemplated are as simple as they are effective and beautiful. So simple are they, indeed, that the excellence of the invention will be obvious at a glance; and the first thought that strikes us on examining the models is one of wonder that the expedient has never been thought of before.

Briefly stated, the invention for dispensing with the elevated guide framing consists in placing the channel or other guides within the tank at an angle, like the thread of a screw, instead of in the vertical plane, as has hitherto been the invariable practice. The guide rollers attached to the bottom curb of the holder are ranged either radially or tangentially with the sides of the vessel; and as they work in the channel or rail guides provided for them, a helical or screw-like motion is communicated to the floating vessel as it rises and descends in the tank. The arrangement is shown in the accompanying figure.

The guides attached to the tank sides may be placed at any angle from 45° upward. In the models before you they are fixed, one at an angle of 45° and the other at 60°, which latter is probably the most suitable for single-lift holders. The effect of thus arranging the guides is obvious. So long as the rollers are free to move within the guides, it is impossible that the holder can tilt so as to get out of the vertical; the tendency of wind or other pressure exerted against the sides or on the roof of the vessel being to produce what may be described (imperfectly, however) as a locking action, which will sustain the holder in the upright position, however great the strain, within the resisting strength of the rollers and their carriages. While this locking or gripping action gives rigidity to the vessel, enabling it to resist the overturning force, the rollers are perfectly free to rise and descend within the guides.

Adopting Mr. Webber's description—and I see no reason to question its accuracy—that the gasholder, as at present constructed, may be compared to a pole whose lower end is placed in a socket, *though not resting on a base*, it may be pointed out that it is just the absence of this bottom bearing which accounts for the inherent weakness of such structures. It will be seen, however, that the holder, as now proposed to be guided, has almost as positive and substantial a bearing as it would have if lifted bodily out of the tank and placed upright on the ground. It is in this that the chief value of the invention consists; for at the present time the tank guides, owing to their vertical direction, afford no actual security against tilting—their only office being to prevent the swaying of the vessel to and fro when under stress of outside pressure.

It is evident, further—and this is a most important consideration—that immediately the strain comes upon any part of the holder under the new conditions of guidance, the resisting action of the whole of the guides, both front, back, and sides, is brought into



operation, one-half the rollers being in tension and the other half in compression; and the vessel is literally held with (to use a paradoxical expression) a grip rigid yet loose.

It will be seen, therefore, that by the proposed new method of construction, the guides within or upon which the bottom rollers work answer not merely the purpose of guiding the vessel in its rise and fall, but also serve as cramps or grips, withstanding, by their locking power, whatever strain may be exerted against the holder, whether laterally on the sides, or perpendicularly upon the roof. As a matter of fact, the effective capability to resist strain—assuming that the floating vessel and its trussing are sufficiently strong—is only limited by the strength respectively of the guides and that of the carriages and rollers.

It may be suggested that a holder thus guided and kept in the upright position solely from the base will need to be strengthened in the upper curb, so as to overcome the crushing force exerted by wind on the sides. A moment's consideration, however, will show that this is not necessary. As at present constructed and guided, gasholders are capable of resisting the maximum crushing strain that is exerted by the greatest wind pressure upon their exposed side—*i. e.*, a pressure equal to 20 lb. to the square foot exerted upon a plane represented by 50 per cent. of the area of vertical transverse section of the holder. The elevated framing does not relieve the crushing strain in any degree; on the contrary, it assists or aggravates it by presenting a rigid support to the leeward side of the vessel. I should scarcely have mentioned this, had it not been urged as an objection.

The only possible danger that can arise is that of distortion or dislocation; and this can readily be obviated by giving the vertical supports or stays inside the holder more of the form of a girder than at present. Probably the triangular form, with the base of the triangle at or near to the bottom curb of the holder, would be the best. These would receive the strains exerted against the sides and roof of the vessel, and transmit them to the bottom curb and rollers, and thus secure the stability of the whole. It will be urged as an objection to this that the effect will be to add weight to the holder which was previously in the guide framing. Any such addition, however, if required, will be trifling as compared with the weight of the guide framing as at present constructed, and will be very far from neutralizing the economical advantage of dispensing with this framing altogether.

With the exception above noted, there need be no change in the mode or materials of gasholder construction. It is not unlikely that steel may be employed more generally in these structures than heretofore; and this, while allowing a reduction in the weight, will greatly increase the power of the trussing to resist strain from outside.

It may be pointed out that the probable cause of most of the accidents which have arisen in the overturning of gasholders under wind pressure was owing to the want of rigidity in the bottom carriages and rollers, allowing of the swaying to and fro of the floating vessel, thus causing the sudden impact against the vertical columns, which have been snapped off by the blow; and the holder, being guided at neither top nor bottom, has been overturned by the wind. It is one of the chief merits of the present invention that rigidity of the rollers is secured as a natural consequence of the method of arrangement of the guides, and is not dependent on either the skill or the attention of the workmen employed in construction and erection.

The ordinary method of counterbalancing gasholders, where counterbalancing is required (as in the case of holders whose diameter is small when compared with their depth), will not be necessary under the proposed system; for the same result will be obtained by increasing the length of the roller path, by placing the guide rails in the tank at a less angle.

Perhaps it will be suggested that, with the tank guides constructed and fixed as described, there will be difficulty experienced in raising the holder for repair when the water is out of the tank. This objection has no force. All that is required under the new conditions is to arrange the lifting screws and chains so that the pull will be in a slanting direction, when the vessel will be raised with as much ease as at present.

Exception may be taken to the invention from an æsthetical point of view. It may be urged, with some show of reason, that the only possible ornamentation in connection with a gasholder is supplied by the elevated guide framing, and that wanting this the floating vessel standing above ground without apparent support will be a somewhat ungainly object. True, the holder might be ornamented round the top ring with palisade or open checker work; and other methods of ornamentation may be adopted. Whether this be so or not, however, appearance will not weigh for one moment with those who are concerned in providing the capital required to be expended on such structures; and neither ought it to do so, when the advantage in the saving of cost is so manifestly in favor of the proposed method of construction. This saving is not confined to the ironwork of the holder, but extends also to the underground tank. The necessity for the provision of piers or counterforts, and large and expensive foundation stones for the bases of columns or standards, will disappear; the tank for such a holder being cylindrical both inside and outside the walls, from base to summit. Again, in the case of holders made for shipment abroad, there will also be the saving of about 50 per cent. effected in the cost of freight. In these days of active rivalry in the methods of artificial illumination, whatever improvements tend to keep down the capital of a gas works will be welcomed.—*Journal of Gas Lighting.*

* A paper read before the Manchester District Institution of Gas Engineers, Aug. 25.

THE SAULT STE. MARIE CANALS.

THE two largest inland seas of America, Lakes Superior and Huron, are connected by a short river, the Sainte Marie, about 75 miles in length, and through this river and the two great lakes the international boundary between the United States and Canada is established. The River Sainte Marie, the only outlet from Lake Superior, leaves it at its eastern extremity, and empties into Lake Huron, about 50 miles east of the Straits of Mackinaw, through which is the outlet of Lake Michigan, wholly in American territory, and on the same level as Lake Huron, while Lake Superior is about 21 ft. or 22 ft. higher than either. In its natural state the River Sainte Marie was obstructed by shoals and bowlders, and by the rapids and falls of Sainte Marie, about 15 miles from the upper end of the river. These falls and rapids, concentrated within a mile, account for 18 ft. of the total fall, 2·3 ft. being below the falls in a distance of 35 miles to Mud Lake, which is on the Lake Huron level, and about 1½ ft. above the rapids is spread over the 15 miles, and is no serious impediment to navigation. From the head of the river at Pointe aux Pins, from which the navigation of Lake Superior commences, is 266 miles to Port Arthur, the principal Canadian port in the north shore of the lake, and 390 miles to Duluth, the principal American port at the extreme west of the lake, while from the foot of St. Joseph's Island, the extremity of Lake Huron, to the Straits of Belleisle on the Atlantic is 1,938 miles, all navigable now by the Canadian canals and the St. Lawrence for vessels of 600 or 700 tons burden.

Fifty years since, the whole country round Lake Superior was almost in a state of nature. Here and there some mining adventurers were prosecuting their explorations with more or less success, and the large fur companies had a few stations scattered round the 32,000 square miles of the great lake, but the greater part was unexplored, and the Sault Sainte Marie was the vanishing point of the great northwest of Canada and of the States, beyond which nearly all was mystery and uncertainty. The newly created State of Michigan was commencing its career, and in the first annual message transmitted by the governor the importance of a canal round the Sainte Marie Falls was pointed out as a most desirable improvement. As a result of this a survey was ordered by the general government, and in 1852 a grant of 750,000 acres of land was made to the State of Michigan, the proceeds of which were to be devoted to the construction of the canal. The State transferred this grant to a company, and on June 11, 1856, the canal was complete and handed over to the State government. This canal was 5,400 ft. long, and near the lower end were two locks, each 350 ft. long, 70 ft. wide, and 12 ft. deep, and lifting 9 ft., the locks being large enough to take in a tug steamer and three of the vessels then ordinarily used in the Lake Superior trade. The walls were of cut limestone from Marblehead, Ohio, backed with stone from Drummond Island in Sainte Marie River, and after a lapse of thirty years are still in good condition. The water was admitted to the locks through openings in the gates, each lock requiring seven minutes to fill. The canal was all that was expected or required, and in the first season 100,000 tons of shipping passed through the locks.

In 1869, in spite of the check occasioned to the trade of the country by the civil war, the traffic had increased to 500,000 tons, and complaints were beginning to be made of the growing inadequacy of the locks for the trade of the country. The copper and iron ore trades were now thoroughly established, and the position of Duluth as one of the avenues of the Pacific trade was beginning to be recognized. Pressure was consequently brought to bear on the question not only of a

larger and deeper canal, but of improvement on the navigation throughout, so as to obtain a safe 16 ft. channel between the two lakes. A sum for the enlargement of the canal was voted in 1870, and each year subsequently until 1881, at which time the new locks were nearly completed, when the whole undertaking was transferred from the State to the federal government, and the construction and management was vested in the chief engineer's department. On September 1, 1881, the new lock was opened for general traffic, though the full enlargement was not complete until 1883. The new lock is placed parallel to, and outside of, the old ones. It is 515 ft. long between the gates, and 80 ft. wide in the chamber, narrowing to 60 ft. at the lock gates. It has 17 ft. water on the miter sills and has a lift of 18 ft. The gates are worked by hydraulic power, and the water passes underneath the lock in communication with the upper and lower level, and is admitted to the chamber of the lock or withdrawn from it through a series of apertures in the cut stone bottom of the lock, so that there is no wave or motion in the water while filling or emptying, but a gradual rise and fall over the whole surface. The prism of the canal varies from 108 ft. to 270 ft. in surface width, while the western entrance from Lake Superior, where vessels principally lie, is from 300 ft. to 500 ft. in width. The total cost of the new work was $2,400,000.

The new lock was brought into operation not a moment too soon. For the fifteen years preceding 1884, the annual increase in the registered tonnage using the canal was comparatively uniform and averaged 107,313 tons per annum. In 1884, however, the increase was 955,578 tons, which was equal to the whole business that had passed through the canal from 1855 to 1860, the first five years that the canal was in operation. Up to 1881 the greatest draught permissible was 12 ft., and the old locks and canals were kept in operation expecting that the smaller vessels would pass through these, and if necessary relieve the new lock to that extent, but with the increase in draught to 16 ft. the whole character of the business changed also, and in 1884 only 11 per cent. of the freight passing the canal could have used the old canal. The freight for 1881, when the enlarged lock was first used, amounted to 1,567,741 tons, and by 1885, this had increased to 3,256,698 tons, or more than double in four years. The business since the new lock was brought into operation seemed to increase out of all proportion to the most extravagant expectations, and in a report submitted to the government January 14, 1885, it was pointed out that should it continue to increase for the next four years as it had done in the past, the existing lockage system would be utterly inefficient. A project was consequently submitted to substitute one new lock for the two old ones now obsolete, without disturbing the lock of 1881, which up to 17 ft. draught is all that is requisite.

The principal freight on the canal is coal and lumber upward, iron ore, copper, and grain downward, and these items thus cover six-sevenths of the whole trade. The heaviest item is coal, which, from 3,500 tons in 1855, slowly increased to 20,000 tons in 1870. In 1880 its volume had reached 170,000 tons. The new canal in 1881 jumped this up to 295,000 tons, and in 1884 it exceeded 700,000 tons. Copper had grown from 3,500 tons in 1855 to 36,000 in 1884. Iron ore, nothing in 1855, and 12,000 tons in 1857, reached 1,112,828 tons in 1884. Lumber, which for twenty years after the opening of the canal did not average a million feet board measure a year, in 1884 reached 131 million feet—over 200,000 tons—while wheat, which made no separate return at all until 1870, reached a total of 14 million bushels in 1884, having clearly doubled in the last year. In 1884, it became necessary to light the canal throughout with electricity, a ten-light dynamo on the Brush system being run by the turbine in the machine house.

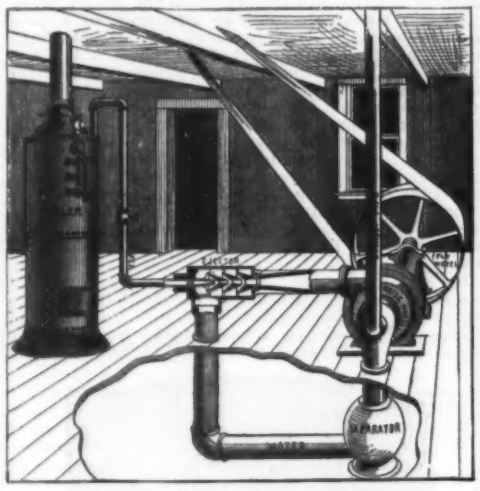
In 1885, altogether 5,043 vessels, aggregating 3,035,937 tons, passed through the canal. In 1886 there were 3,380 steamers, 2,033 sailing vessels, and 290 rafts and unregistered craft, carrying 922,158 tons of coal, 32,615 tons of copper, 1,696,263 barrels of flour, 17,346,312 bushels of wheat, 1,529,031 tons of iron ore, 73,691 tons of pig and manufactured iron, 136,664,000 ft. of lumber, 3,434 tons of silver ore, and altogether 3,701,014 tons of freight. In 1887 the tonnage was 4,388,691, and the freight carried 4,882,802, being an increase of 24 per cent. in tonnage and 32 per cent. in freight over the preceding year.

As compared with the Suez Canal, in 1886, the St. Mary Canal was opened 220 days, and passed in that time 3,520,184 registered tons, or an average of 16,000 tons per day, or as 8 to 8·7 of the traffic of the Suez Canal. In July the Suez Canal had 528,671 tons, while the freight through the St. Mary Canal was 561,228, or 32,567 tons more. Since then the traffic on the one has largely increased, while on the other it has somewhat retrograded. In 1885, 3,620 vessels, aggregating 6,335,753 tons, passed through the Suez Canal, the net receipts from which were $13,009,909, or an average of $2.05 per ton of the vessels using the canal. If the same rate had been charged at "the Soo," the receipts would have amounted to $7,235,827, or two and a half times the whole cost of the canal.

It is now proposed to give the canal a depth of 21 ft. throughout, so as to secure 20 ft. draught for vessels, and to replace the two old locks of 1855, now useless under the changed conditions of the navigation, with one lock 800 ft. long between the gates, 100 ft. wide in the chamber, with 21 ft. water on the miter sills and an 18 ft. lift. The estimated cost is $2,055,576 for the new lock and $196,000 for deepening the canal. Simultaneously with the commencement of the works in the American side of the Ste. Marie River, the Canadian government are calling for tenders for the construction of a new canal on the eastern side of the international line, through the island of St. Mary; the work being let in two sections, one for the canal and locks, the other for deepening and widening the channel way at both ends of the canal, and the construction of piers and booms. The scheme also contemplates the utilization of the water power on an extensive scale, for which the Canadian side of the channel is admirably adapted. The tenders for the work will be received until October 23 next. The new railway bridge opened on the last day of 1887 crosses both the American and Canadian canals in the vicinity of the locks, and the line will be in immediate connection with the hydraulic power that will be developed on the Canadian canal.—*Engineering.*

A STEAM WATER WHEEL.

THE efficiency of water turbines has been brought to such a very high degree of perfection that it is not to be wondered at that inventors should turn their attention to this machine, with the hope that this efficiency may be obtained by the use of steam as well as water. Although no really practical success has yet rewarded their efforts, we must say that the engine we describe, and which is shown in the engraving, seems to be a step in the right direction, although not yet carried as far as is possible. The use of steam in a turbine is certainly a material departure from the practice of the day, which is to obtain work from steam by means of variations in its pressure, and does not consider the velocity of the steam at all in the problem. The reasoning of those who have experimented with steam turbines has been this. The water has pressure due to its head, and so has the steam head, due to its pressure, and if a turbine was placed to oppose the flow of steam, the force of the steam would be given up to the wheel. A turbine was to be used of such character that when



A STEAM WATER WHEEL.

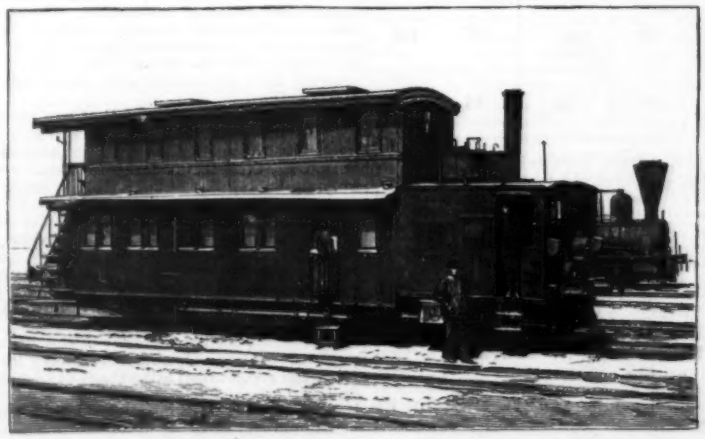
the steam left the wheel, the velocity of the steam shall be reduced to the utmost extent. This was using steam by reaction, instead of by pressure. This is not new, however, because as long ago as 130 years before Christ, Hero of Alexandria built a steam engine upon this principle, and this invention is the more remarkable when we consider that within a few years, practically, this same engine has been introduced and sold as an economical steam engine. We refer to the Avery engine, which was proved to be as economical as a slide valve engine, and yet was almost identical with that invented by Hero over 2,000 years ago. But while steam has "head," due to its pressure, it is lacking in the other property of water, weight; consequently, the velocity of its flow is something enormous compared with that of water, and herein lies the whole difficulty. The power of a steam turbine depends upon its speed, and as this is, in the most successful one on the market, between 15,000 and 18,000 revolutions per minute, its utility for ordinary purposes, it will be readily seen, is very slight, since, by the time its speed was reduced to that in ordinary use, its power would be materially impaired by friction. So, gradually, these steam turbines have been abandoned, except one lately designed in England, but which is only recommended for running dynamos. The parallel-flow type of wheel was the one adopted, and forty-five of these wheels lie on each side of the central steam inlet and are mounted on a single shaft. The steam as it passes through each turbine gives up pressure and enlarges its volume four per cent. less blade area than that of its neighbor. The steam enters at 70 pound pressure, passes through the first turbine, and is reduced about three pounds in pressure, and so through each of the forty-five, being reduced in pressure in each until it exhausts at 15 pounds absolute. This engine is reported to have an efficiency of 72 per cent. of the total mechanical energy of the steam, but as its speed is 18,000 revolutions per minute, its value is limited despite its efficiency.

The practical failure, then, of these engines lies in the fact that steam does not have weight enough to be used for work. The next step, then, is to give the steam weight in some way. We have the pressure, now density is wanted, and in the engine shown this is done by adding water to the steam. In this way the speed of the turbine can be reduced. The steam will flow at a rate due to its pressure, but if it was one-half water, the pressure of the steam would be utilized, but the flow of the combined steam and water would be only one-half as fast as the steam alone, and if we could add water until no steam was present, the flow would be of a velocity equal to water alone of, for instance, 120 feet head, and one turbine would give as much power, but at a greatly reduced speed. What was desired was to give weight to the steam, and this could be done by having very wet steam, or use dry steam, and set a body of water in motion, as is done in the injector. The steam gives up its energy to the water, and the water has not only this energy but a greater density than steam in converting this energy into work. In this case, then, we have what was missing to run a turbine with steam as the prime motive agent. To repeat, then, in the pressure of the steam we have what corresponds to the height of the fall which supplies the water for power, and in the water we have the weight. The pressure in the boiler is capable of moving a certain amount, and the heavier the weight of the liquid moved the slower will be its velocity due to the force applied. No more power can be obtained from the steam than it contains, and the object of adding water, or giving weight to the steam, is simply to reduce the speed in the use of an engine of this character.

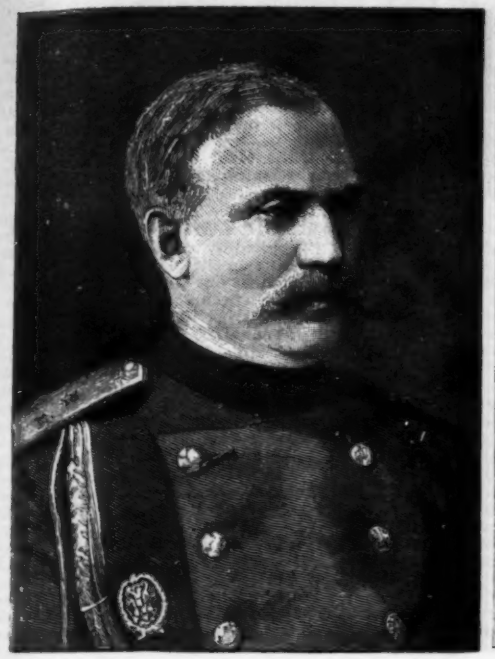
The engine we have the pleasure of showing in the engraving does not represent the perfection to which this principle can be carried, but only proves the possibility of such. An engine of this description can be designed and mounted upon the shaft of a dynamo and take up no more room than an ordinary pulley, and run at very high speed, and, what is equally important, without the slightest variation in speed, which in the ordinary engine produces the flicker so much condemned in electric lighting. The action of the engine referred to is as follows: Steam enters from the boiler at a convenient pressure through the pipe marked "steam," and thence into an ejector, of which a cross section is shown, and which is of such character as will allow a large volume of water to enter it. The steam coming in contact with the cold water in the ejector is condensed, but though it has changed its outward form, the motion of its particles is retained, but in a less degree in proportion to the difference in density between the steam and the form it assumes. The steam then is condensed, but gives up its motion to the water, which passes onward, through a small turbine, driving it exactly as though it was water under a certain head. The water, it will be remembered, is under pressure, but after it passes through the wheel the energy has been given up to the wheel, re-evaporation takes place, and the steam enters a separator where the water is eliminated. The steam passes out of the top of the separator through the exhaust pipe, while the water returns through the drip to be used over again in the ejector. The more entrained water there is in the steam the better, because in passing through the turbine so many times some of the water must necessarily be carried off in the exhaust, and the entrained water supplies the deficiency which might otherwise have to be supplied from other sources. Once the circuit is filled, but little water is necessary to keep it so, as it will be noted that it is being used over and over again. The machine, while it has demonstrated its practicability, is really yet in an experimental stage, as the goal the inventors have undertaken to reach is that of reducing the speed still further, at least to one tenth the speed it is run by water, and so bring it down to a very ordinary speed with high efficiency, or to retain the speed of the wheel due to the velocity of the water, but to greatly reduce the space the engine occupies, so that, for instance, it can be placed on a dynamo in the cab of a locomotive and take up a space hardly appreciable, to generate electricity for lighting the train or for the head light.—*Boston Journal of Commerce.*

NEW TRANSCASPIAN RAILWAY TO SAMARKAND.

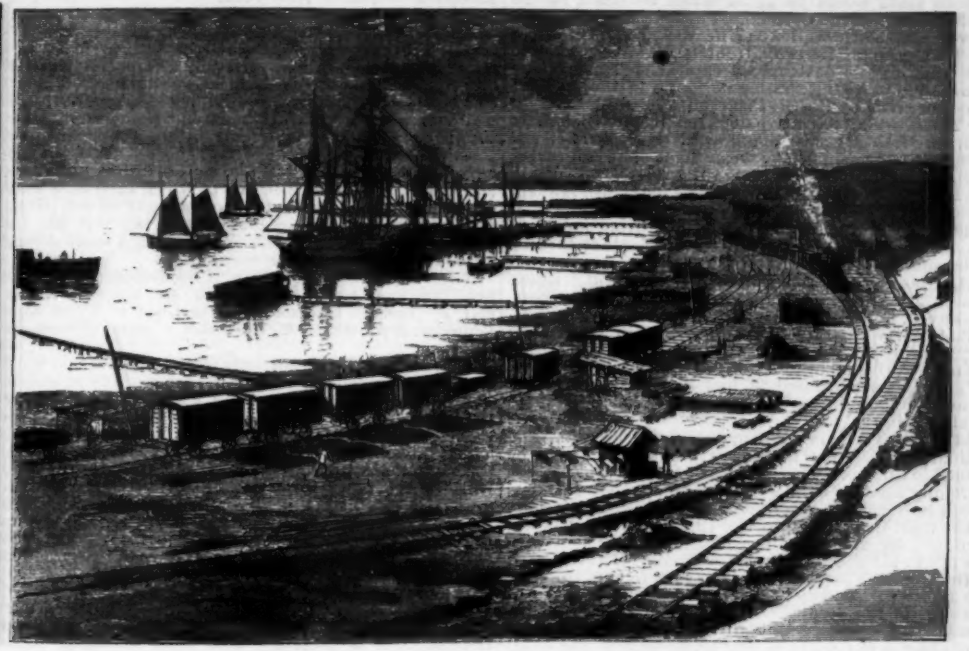
THIS great Central Asian Railway, which has been constructed by Russia to open the interior of Turkestan and Bokhara to her commerce, and to facilitate her military communications with those regions, is 900 miles in length, and runs through some of the most terribly arid and sandy deserts in the world. The line has taken about seven and a half years to construct, though the major part, from Kizil Arvat, has been laid in three years. It has almost wholly been constructed under the supervision of General Annenkoff, and will, it is stated, when matters are in working order, bring St. Petersburg and Samarkand within ten days' distance. The line was formally inaugurated on the anniversary of the Czar's coronation, May 27, 1888, and our illustrations, from photographs supplied by the Rev. Dr. Henry Lansdell, will give some idea of the country traversed. A passenger for Central Asia starting from St. Petersburg would travel by rail as far as Vladivarkas, at the foot of the Caucasus, and then would have



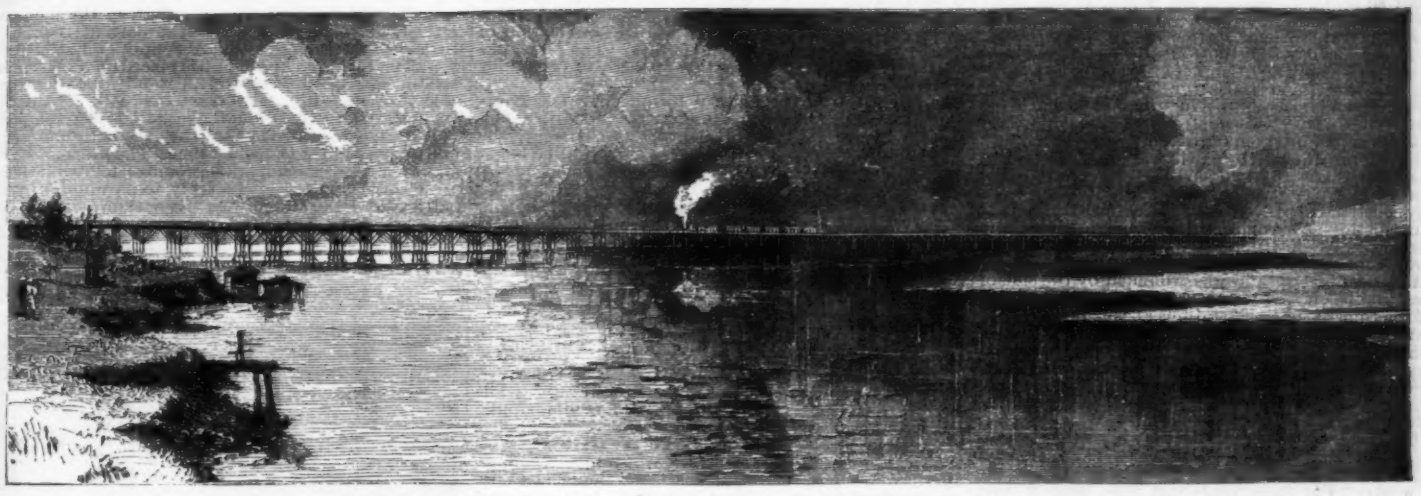
GENERAL ANNENKOFF'S LOCOMOTIVE HOUSE.



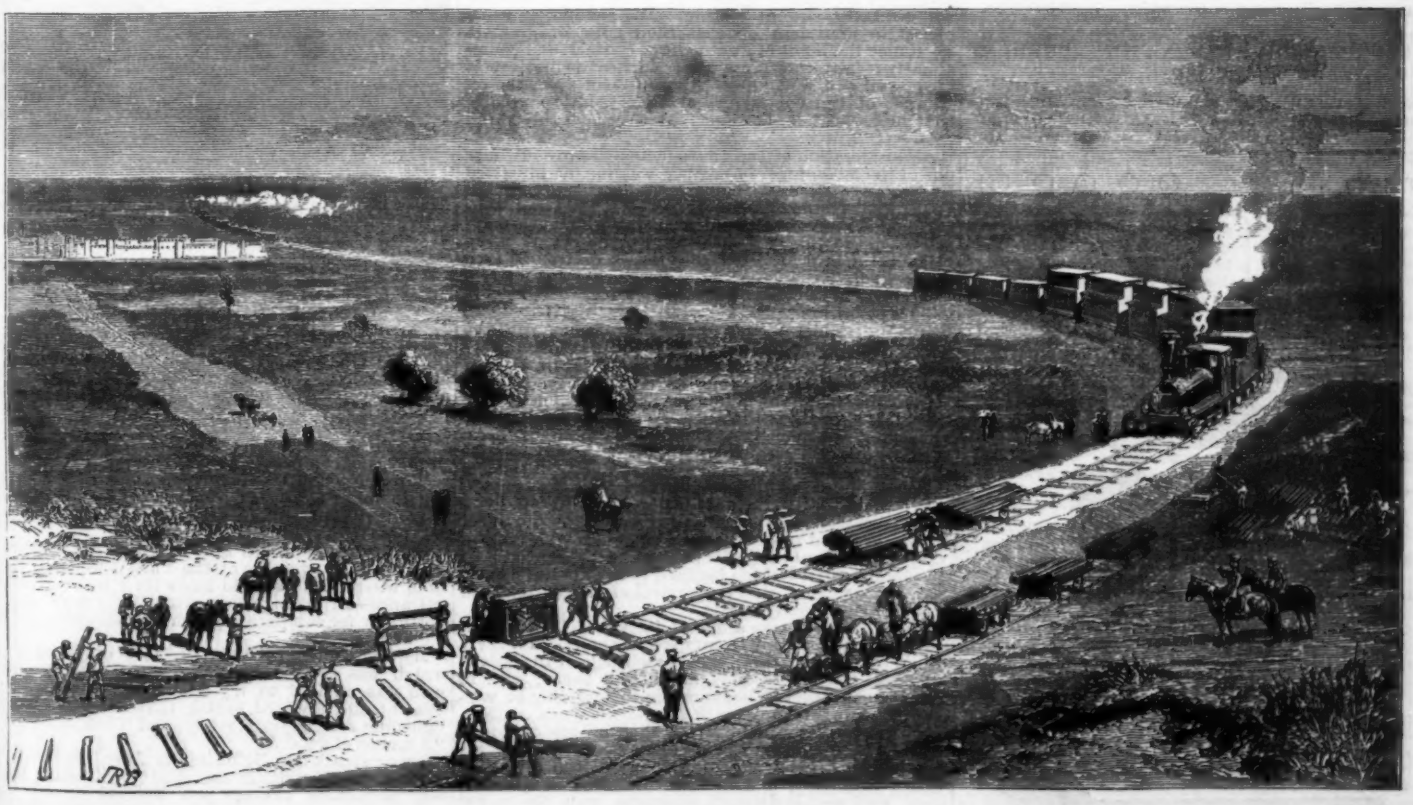
GENERAL L. M. ANNENKOFF
Who Planned the Line



THE WESTERN TERMINUS, OUZOUN ADA, ON THE CASPIAN SEA



BRIDGE OVER THE OXUS, 6,230 FEET LONG, THE LONGEST IN THE WORLD.



LAYING RAILS.

THE RUSSIANS IN CENTRAL ASIA.

VIEWS ON THE NEW TRANSCASPIAN RAILWAY FROM THE CASPIAN SEA TO SAMARKAND.

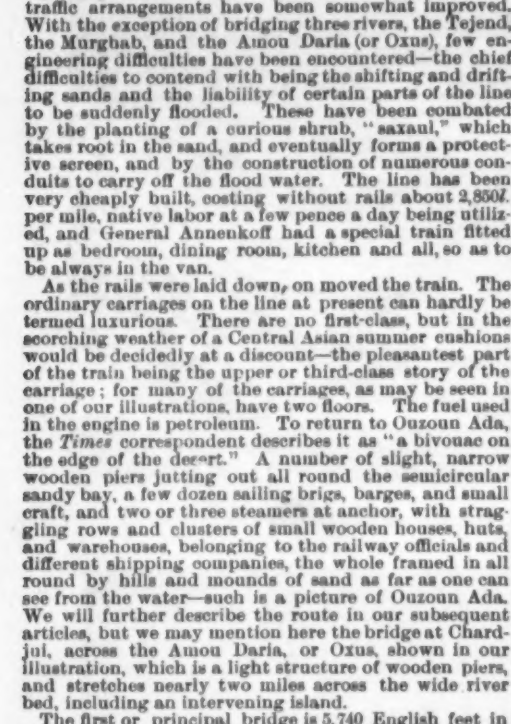
to drive over the mountains, some 150 miles, to Tiflis, whence train would be again taken to Baku, on the western shore of the Caspian. Thence a steamer would convey him to Ouzoun Ada, the western terminus of the Transcaspian Railway, from which place the line now runs to the once famed capital of Tamerlane—Samarkand. An interesting account of the journey has been given by the St. Petersburg correspondent of the *Times*, whose narrative does not inspire the reader with any frantic desire to follow his example until the traffic arrangements have been somewhat improved. With the exception of bridging three rivers, the Tejend, the Murghab, and the Amou Daria (or Oxus), few engineering difficulties have been encountered—the chief difficulties to contend with being the shifting and drifting sands and the liability of certain parts of the line to be suddenly flooded. These have been combated by the planting of a curious shrub, "saxaul," which takes root in the sand, and eventually forms a protective screen, and by the construction of numerous conduits to carry off the flood water. The line has been very cheaply built, costing without rails about 2,850*l.* per mile, native labor at a few pence a day being utilized, and General Annenkoff had a special train fitted up as bedroom, dining room, kitchen and all, so as to be always in the van.

As the rails were laid down, on moved the train. The ordinary carriages on the line at present can hardly be termed luxurious. There are no first-class, but in the scorching weather of a Central Asian summer cushions would be decidedly at a discount—the pleasantest part of the train being the upper or third-class story of the carriage; for many of the carriages, as may be seen in one of our illustrations, have two floors. The fuel used in the engine is petroleum. To return to Ouzoun Ada, the *Times* correspondent describes it as "a bivouac on the edge of the desert." A number of slight, narrow wooden piers jutting out all round the semicircular sandy bay, a few dozen sailing brigs, barges, and small craft, and two or three steamers at anchor, with straggling rows and clusters of small wooden houses, huts, and warehouses, belonging to the railway officials and different shipping companies, the whole framed in all round by hills and mounds of sand as far as one can see from the water—such is a picture of Ouzoun Ada. We will further describe the route in our subsequent articles, but we may mention here the bridge at Chardjui, across the Amou Daria, or Oxus, shown in our illustration, which is a light structure of wooden piers, and stretches nearly two miles across the wide river bed, including an intervening island.

The first or principal bridge is 5,740 English feet in length, and there are two smaller bridges near the Bokharan side. As we have said, the line has been mainly constructed by General L. M. Annenkoff, one of the most distinguished officers in the Russian service, who had had railway construction experience in Lithuania. General Annenkoff himself took part in the last Central Asian campaign, and was wounded by the side of General Skobeleff at the taking of Geok Tepe, which now forms one of the chief stations at which the "Shaitan Arba," or Devil's Cart, as the locomotive is known out there, now halts. He showed the most untiring energy, and among the workmen he was called the "nagaika," or whip, of construction, on account of the indefatigable manner in which he urged on everything and everybody. He has been rewarded by the Czar with the Order of St. Alexander Newsky, the appointment as chief director of the line for twenty years, and by a congratulatory imperial rescript, in which the Czar wrote: "For three years you have labored with characteristic energy at the accomplishment of this task, sparing neither health nor strength, in a constant struggle against natural obstacles which seemed almost insurmountable."—*London Graphic.*

SHALLENBERGER ALTERNATING CURRENT METER.

WE illustrate in the accompanying engraving a form of electric meter designed by Mr. O. B. Shallenberger,



THE SHALLENBERGER METER.

electrician of the Westinghouse Electric Company, and in which electrical energy is converted into mechanical motion, the rate of which is directly proportional to the energy being consumed. We take our account from the *Electrical World* of New York.

The principal elements employed in the construction of the meter are—first, an armature of metal capable of rotation; second, an electric circuit, which is so arranged that when it is traversed by alternating electric currents a field of force is induced having a given polar line or axis with reference to the armature; and third, a circuit so related to the first circuit that currents are produced in such second circuit by the action of those in the first, the phases of which succeed those of the currents in the first circuit and set up for the armature a second field of force, the axis of which intersects that of the first. The armature may be built of soft iron, or of copper or other non-magnetic metal, or it may be composed of a core of soft iron having a conducting circuit of other material surrounding.

Referring to the engraving, A represents a circular armature mounted upon a shaft, *a*, and placed within a coil, B. The coil is made in two sections, b^1, b^2, for convenience of construction, the shaft, *a*, passing between the two.

Alternating electric currents traversing this coil tend to establish a field of force whose polar line or axis is approximately in the direction, *e e'*, at right angles to the shaft, *a*. A second conductor, C, is placed in inductive relation to the conductor, B, and armature, A. This conductor is closed upon itself. It is placed with its magnetic axis at an inclination to that of the coil, B. Alternating electric currents traversing the conductor, C, establish a field of force for the armature, whose polar line or magnetic axis is approximately in the direction, *f f*—that is to say, inclined with reference to the polar line of the coil, B. It is found in practice that when the coil, B, is traversed by alternating electrict currents, the armature will revolve.

In order to produce a rate of rotation of the armature proportional to the amount of energy supplied to the circuit, it is necessary that some retarding force should increase in its effect by the same law as that of the rotating effect produced by the current. If, for example, the tendency to rotation increases as the square of the current, then the retarding effect should increase as the square of the speed. Such a definite law of increase of retardation is secured by the application of fans or vanes, N, fixed to the shaft, *a*. The resistance offered by the air to the rotation of these vanes affords the required retardation.

This meter is said to respond to the currents traversing the coils, B, in such a manner as to obtain a reliable and accurate measurement of the current, the number of revolutions performed in a given time being directly proportional to the current consumed during that time.

It is found, in practice, that the resistance of the coil, B, may be made very small, and the current consumed in operating the meter itself quite insignificant.

The number of ampere hours are recorded by the registering train geared to the shaft.

ELECTRIC WELDING.*

By OTIS K. STUART.

THE process of electric welding, which was discovered by Professor Thomson some eleven years ago, while lecturing at the Franklin Institute of Philadelphia, has been developed in the past two years to a far greater extent than is generally supposed. We started in with the welding together of small wires of iron and copper, and have been so successful in the development of apparatus that we are now able to weld bars of a very large size and of almost any shape or metal.

The principle involved is that of forcing through a conductor an amount of current which the conductor will not carry without heating. Any conductors when placed in abutment have as their point of greatest resistance the point of abutment or contact, and consequently it is at this point that the heat is first generated; and as is well known, this heat increases the resistance of the conductors at that point so greatly that more heat is developed at a remarkably rapid rate.

A consideration of the above facts will prove at once one of the advantages of electric welding, as practiced by Professor Thomson, namely, the localization of the heat to the points or point at which it is desired, thus saving an enormous amount of energy which is usually wasted in welding with the forge or flame. So absolutely is the heat localized, that pieces of iron 3" long and an inch in diameter can be welded together and then held in the hands for some time without any danger of burning, the only heat which is felt at all being that which is conducted along the metal to the hands after the welding is completed.

A further consideration of these facts will also demonstrate that it is possible by the Thomson process to weld any metal, including even those which melt at a very low temperature, such as lead, zinc, and tin, and those which melt at enormously high temperatures, as for instance iridium, platinum, etc. Of course it goes without saying that we can weld any of the metals used in ordinary manufacture.

It is plain that if the heat is developed so rapidly, a very delicate means of controlling it must be provided, and we are glad to say that we have been able to provide arrangements for this purpose which are almost absolutely perfect—I am inclined to say absolutely perfect, for the reason that the control of the current can be made entirely automatic.

We are able to take a bar of inch iron 4" in length, raise it to a dull red in twenty seconds and hold it there for an indefinite period; to increase the heat to a bright red in a very few seconds, and hold it there; then to still further raise the temperature to a welding or vaporizing point, in a remarkably short space of time. This indicates the delicacy of this apparatus, and I would add that no very great skill is required to operate the machine, a boy learning to weld iron and steel with great facility in a week or two. The time required to weld metals depends, of course, upon the power of the apparatus and the skill of the operator. We have made strong and practically perfect welds in half-inch round wrought iron in six seconds; in inch round wrought iron in forty-five seconds; and so on. Experiments have proved to us that the power required to weld is proportional, or very nearly so, to the area of cross section of the pieces; this is true of nearly all the metals, though, of course, the relative resistance and welding temperature of the several metals may interfere with this ratio.

For welding small wires, such as telegraph or telephone, and the smaller sizes of electric light and power lines, the power required is very small indeed; the momentum of heavy machinery being more than enough to effect the weld. In this connection I desire to say that we are now working to perfect an apparatus for welding telegraph, telephone, and electric light wires and lines of pipe on the line. Our experiments in this direction have been successful, and we now think it possible to construct an apparatus which will be capable of being moved about by one or two men, and which will make joints in wires correctly and durably, the energy used being supplied by storage battery or batteries, forming a welding outfit. For repair work and in general construction it is our belief that this apparatus will be found very useful and effective; in fact, we hope to do away entirely with the ordinary solder and link joints used at present.

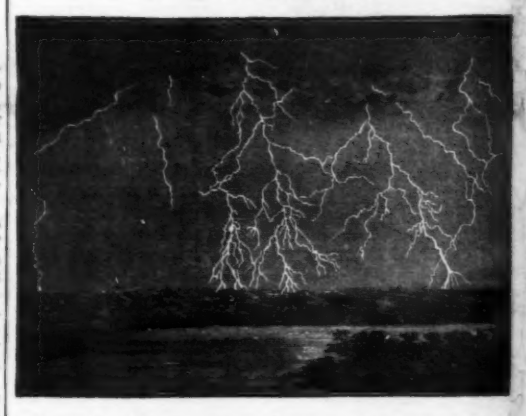
The cost of such an apparatus will be very slight, and there would be a small royalty of a definite amount per 100 or 1,000 welds, as the case might be. This policy of placing an apparatus on the market has been adopted for the reason that our patents cover not only the apparatus for electric welding, but the art or process as practiced by Professor Thomson. It is hardly necessary to add that, by the same process, we can solder, and braze, and anneal, and temper, and do other heating, local or otherwise, which cannot be done economically by present methods. All these operations can be performed with the same apparatus, though, of course, it is better to have machines specially constructed for particular work.

At the conclusion of the reading Mr. Lang stated that he had seen one of these machines in operation when a bar of cast steel and one of copper were welded together.

One would suppose that the metal most easily fused would burn away before the other was brought to a welding heat. This is not the case, however, and it is very simply provided against. The current is brought to the bars through clamps which grasp the bars near to the ends to be welded, and the current is brought through these clamps. Where copper and steel are to be welded together, the clamp is placed about six inches back on the copper bar, while it is only about one inch from the point of contact on the steel bar. In this case the heat is diffused through a large body of the metal which is most fusible, so that they are both brought to a welding point at the same time. The process is something really wonderful, and promises to revolutionize the ordinary method. In reply to an inquiry by Mr. Lattig, Mr. Lang stated that the system is now in constant use at the Thomson-Houston factory in Lynn.

* A paper read before the Association of Railway Telegraph Superintendents, New York, July, 1888.

PHOTOGRAPH OF A LIGHTNING FLASH, TAKEN AT WAKEFIELD, MASS.



THE above figure represents a remarkable lightning flash which was photographed recently during a storm at Wakefield, Mass.

PROTECTION OF WATCHES AGAINST MAGNETISM.*

By C. J. H. WOODBURY, Boston, Mass.

THE growing and even general use of electricity for illumination and for the transmission of power has added much to the knowledge of electrical phenomena, and also called the general attention of the public to matters long known to those familiar with physical science.

The introduction of iron ships first presented new problems of compass adjustment and chronometer protection, in which the disturbing effect of the magnetism in large masses of iron is compensated by means of smaller masses of iron, arranged to turn or to counteract these lines of force.

Public attention was first called to the influence of magnetism on watches at the Paris Electrical Exposition, where visitors could leave their watches near the entrance—an arrangement which gave wits ample opportunity for comparisons with pawnbrokers and bathing houses.

My first experience with the effects of electricity on a watch was comparable to that of the good old soul who was advised to try electricity for some chronic ailment, and declined, saying that she was struck by lightning several years before, and it had not done her "a morsel of good."

I was struck by lightning in July, 1881, at a time when I was thoroughly drenched with water; and the only permanent damage was received by my watch, which was marked on the back of the case with two straight black stripes, each about half an inch in width, extending across the back and joined together at one end like a letter V. Three of the arbors in the movement were broken, but there was no discoloration except on the outside.

Another watch, which possessed a remarkably uniform rate, and was highly valued for its accuracy,

* Read before the American Association at Cleveland.

yielded to the temptation offered by the magnetic fields around dynamos, and became very uncertain, losing time at irregular intervals and at varying rates.

The usual methods of demagnetization, such as revolving magnetic fields, twirling the watch slowly out of a strong field, and reversals of magnetization, were all tried with the result of lessening the evil, but not removing it, as it seemed to be impossible to bring back the movement to the old rate.

There have been many expedients for removing magnetism from watches, the latest bit of charlatanry being to bury the watch in the ground—a proceeding which, it is needless to state, would ruin a watch, but not affect its magnetism.

It is surprising how weak a magnetic field will stop a watch, a small magnet being sufficient for the purpose; and far weaker magnetic fields will interfere with the rate of a watch to an extent which will injure its value as a timepiece.

There are two types of attachments designed to protect watches against magnetism, one being a small disk of iron taking the place of the inner cover of a watch case, and the other a box or case surrounding the watch case like the outer case of a bull's eye watch. Without indorsing any of the extreme statements declared to be fundamental principles of magnetism by those engaged in the sale of either of these devices, it is evident that any magnetic body will distort lines of force in a magnetic field; and it was considered worth while first to submit the metal case to direct experiment.

The magnet used was a small dynamo, containing cast iron to the weight of about 450 pounds. The armature was disconnected from the circuit, and the field coils connected to an electric circuit, in order that the watches should not be subjected to jar from a revolving armature.

Remembering the engraving published in some of the electrical papers, representing one of these cases in a magnetic field, and covered with iron filings bristling in all directions, while filings inside were in repose, a circular piece of cardboard was placed in the case and dusted over with iron filings which had not been magnetized, and the box was closed and placed on a block of wood a foot from one of the poles of the magnet.

An electric current sufficient to saturate the magnet passed through the field coils for a few moments, and the circuit was broken before the case was opened, in order that the contents should not be directly exposed to any attraction except what was transmitted through the iron forming the case. On opening the case it was seen that the iron filings had been drawn toward one side of the card, and arranged in striæ in the ordinary manner whenever they are exposed to a magnetic field.

A watch which had been set to exact time with one in an extreme part of the room was placed in the case, and in like manner exposed to the magnetic field for five minutes.

When the case was opened, it was found that the watch had stopped at the instant that the magnet was charged; and the movement has been magnetized to an extent which has robbed it of any present value as an accurate timepiece.

At the same time a Waterbury watch exposed to the same conditions, except that an iron case was not used, stopped when the magnet was saturated, but started again apparently uninjured as far as could be learned from a day's run.

As it was evident that the case did not adequately protect the watch, experiments were not made with the shield referred to, which contained a small fraction, perhaps one-tenth, as much metal as the case.

These watches were not exposed to any more severe tests of magnetism than would be liable to be offered to a watch worn on the person of one around a dynamo or motor, except that a passenger in a motor car would naturally be in a sitting position, and the watch would be exposed for a longer time to lines of force than would be the case around a dynamo, where the person would not probably remain in a stationary position so long a time.

Some time ago I examined a watch containing the inventions of C. A. Paillard, of Geneva, in which the hair spring and balance were made of alloys of palladium, the escapement being made of steel, and found that although a weak magnetic field did not produce any apparent effect upon the movement, yet it was stopped by exposure to a very strong attraction.

This difficulty would be intermittent in its nature even under the extreme conditions of magnetic force which stopped the watch, because the balance and hair spring were composed of non-magnetic alloys.

Subsequently, when the same make of watches were produced containing the whole escapement as well as balance and hair spring composed of alloys of palladium, I bought one subject to guarantee, and exposed it to the tests mentioned above without stopping it or interference with its rate.

It is probable that long continued exposure to an intense magnetic field would tend to accelerate the rate of such a watch, because the resistance to cutting the lines of force would slightly reduce the length of the arc of vibration, and therefore increase the number of beats during a given time; but I have not had time to learn by experiment whether these conditions of continuous exposure to an intense magnetic field could under any circumstances affect the rate of such a watch. It is evident, however, that a watch worn on the person would not be exposed for a sufficient length of time to receive any modification of rate. In any event, such influence upon rate would not be permanent, but would continue only while the rapidly moving parts were cutting lines of force in a magnetic field.

The alloys of palladium referred to possess an elasticity comparable to steel, as is shown by its practical operation. It is undoubtedly not oxidizable in moist air; and the alloys, being composed of both paramagnetic and diamagnetic metals, must approximate more or less closely to a neutral substance.

Several of the types of watches made in this country have been advertised as containing non-magnetic movements, using alloys of other metals than palladium.

Before purchasing the Paillard movement, I endeavored to examine, with a view of purchasing, some of those movements, but they were not on sale at the time.

The conventional claim of enthusiastic inventors is that their productions are going to revolutionize the whole world, or perhaps only the specialty to which their inventions pertain; but the experience of the writer shows that the present use of dynamos, and the prospective general introduction of motors, especially upon street railways, will render watches which are unaffected by magnetism a general necessity.

IMPROVED APPARATUS FOR TESTING AND ANALYZING GASEOUS MIXTURES.

IN the third number of the *Zeitschrift für Analytische Chemie* for the current year various improvements in apparatus for the analysis of gases are noticed. A brief description of some of them may be of interest to our readers.

An apparatus designed by Herr F. Fischer consists mainly of three upright tubes—(1) a long laboratory tube, in which absorptions and explosions are conducted; (2) a measuring tube or eudiometer, surrounded by a water jacket to insure uniformity of temperature; (3) a pressure tube connected in the usual manner with the eudiometer. The absorbent liquids and water for cleansing purposes are admitted to the laboratory tube from a receptacle at the top, by means of a stopcock; while the transference of gas from the laboratory tube to the measuring tube and *vice versa* is effected by raising or lowering mercury reservoirs connected to the bottom of each tube respectively, and shut off when necessary by clips. There are two stopcocks between the laboratory and measuring tubes. The one nearest the latter tube is a simple stopcock, and serves to shut off the measuring tube; while the other is a three-way cock, and permits of connection being made with the external air. It serves for the introduction of the gas for analysis in the first instance, and subsequently to admit gaseous reagents, as well as for the egress of wash water, etc. In apparatus of a somewhat similar character, Mr. Alfred H. Allen uses a Lunge's nitrometer for the measuring tube, while Mr. Sinibaldi places the measuring tube in the pressure tube, and Mr. J. B. Mackintosh, in a modification of Elliot's apparatus, has among other conveniences an arrangement by which the gas under examination can be shut up in the measuring tube during the introduction of oxygen or air for explosion, and hence avoids any possibility of loss.

Many modifications of Bunte's and of Orsat's apparatus are proposed; but the simple arrangement devised by Herr Franke, shown in the annexed diagram, is suggested to replace them for technical purposes, and more especially for the analysis of chimney gases. It consists of a glass tube of a capacity of exactly 100 cubic centimeters (including the wide bore of the middle stopcock), enlarged at the upper end, A, and graduated on

the narrower part. The upper end terminates in quite a small tube and stopcock, while the lower end is connected by means of a wide bore stopcock with a glass chamber, B, which is intended for the introduction of reagents, etc., and can be closed air tight at will by means of a hollow glass stopper, fitted with a tube and stopcock. When in use, the apparatus is best filled by allowing the gas for examination to stream through it. If, however, only a limited quantity of gas is available, the apparatus is filled with water, the stopper fixed in, and the upper narrow tube connected with the source of gas. All the stopcocks are then opened; and when the water has run out to about half way down the reagent chamber, the upper stopcock is closed, and the whole apparatus transferred to a stand and supported in a vessel of water, where it is adjusted so that the levels of the water both inside and out are at the same height. The wide bore stopcock is then closed.

The apparatus now contains a definite volume of gas under the prevailing atmospheric temperature and pressure; and it can be treated and agitated with various reagents in the following manner: Remove the stopper and fill the chamber with the reagent, replace the stopper, open the wide bore stopcock, allow the reagent to flow into the tube, and close the stopcock before all the liquid has flowed in; then agitate well, and finally let the reagent flow into the chamber again; wash out the reagent chamber, and measure by adjusting the levels of the internal and external water and reading the graduations.

Herr E. H. Keiser has introduced an apparatus in which the weight of mercury displaced by the gas is ascertained, instead of measuring the volume of the gas in the ordinary way. Herr A. Ehrenberg has constructed an apparatus for rendering the analysis of gases by combustion more accurate.

The following simple appliance is recommended by Herr W. Thorner for the collection and direct analysis of the gases dissolved in water. A flask full of the water to be examined is connected with a measuring cylinder filled with water which has just been boiled and is still warm. The pressure in the cylinder can be increased or reduced by raising or lowering a reservoir connected with it, containing some of the same warm water. The reservoir is lowered, and the flask of water raised to boiling point. The gas collects in the upper part of the measuring cylinder; and, to prevent its being absorbed by the water, oil is run in through a funnel at the top, so as to form a protective layer. The gas is readily measured, and, by means of a three-way cock at the top, beneath the funnel, may be easily transferred to any other apparatus for further examination.

When estimating carbonic oxide, it is well to remember that ethylene is also absorbed by cuprous chloride; ethylene must therefore be removed—*e. g.*, by means of fuming sulphuric acid—before proceeding to dissolve out the carbonic oxide. It is also desirable to use fresh cuprous chloride for each determination.—*Jour. Gas Lighting.*

ON THE REDUCING ACTION OF HYDROGEN IN PRESENCE OF PLATINUM.

By STEPHEN COOKE.

SEVERAL years ago I made some experiments on the action of hydrogen on solutions likely to be reduced by this gas. With hydrogen alone, however, in most cases no action was observed. It then occurred to me that the action might be promoted by the presence of finely divided platinum; for although the action of this substance is so well known in bringing about the combination of gases with each other, it has not, as far as I am aware, been much used to bring about or accelerate the action between gases and liquids. Gladstone and Tribe (*Jour. Chem. Soc.*, xxxiii., 306, 1878) have shown that hydrogen occluded by finely divided metals is analogous to nascent hydrogen. The same conclusion may be drawn from the results of my own experiments, which were, however, made in a somewhat different manner, and were rather more extended than those of the above mentioned chemists.

Most of my experiments were made in tubes closed at one end, and from 300 to 400 mm. in length and about fifteen mm. in diameter. A piece of platinum foil as long as the tube, and of such a width as to pass freely into it, is placed in the tube, and kept in its place by a wire passing through the closed end, and projecting a few mm. from it. The foil can be coated with platinum black by electrolysis, and the coating can be readily renewed without removing the foil by filling the tube with platinic chloride and connecting the wire passing through the sealed end with the zinc end of a battery; the other pole being a wire passing through a bit of small glass tube, and projecting a little from the closed end.

Platinum foil so prepared gradually loses its activity or power in bringing about combination. Between hydrogen and liquids this loss of activity for the most part merely results in a slower action, the *nature* of the change being the same. In the case of some gases, however, not only is the rate but also the kind of the chemical change to some extent influenced by the activity of the platinum; but this may be due to the higher temperature produced, and not to any increased activity of the occluded hydrogen.

The efficiency of the prepared platinum can be readily tested by transferring electrolytic gases to the tube. Perhaps one or two experiments may not be out of place. A freshly prepared tube was rapidly filled with a mixture of electrolytic gases; there was a rapid contraction for five or six seconds, followed by an explosion. In a similar tube which had been in use some months the contraction was much slower, taking from ten to fifteen minutes, and there was no explosion. In a tube containing foil which had not been coated or specially cleaned, the gases took about thirty hours to disappear.

The hydrogen was in most cases made by the electrolysis of pure dilute sulphuric acid, but in some cases by dilute sulphuric acid and zinc.

The experiments were generally made by filling the tube with the solution under trial, then displacing the solution with hydrogen and leaving the filled tube standing in the solution. With corrosive liquids, instead of the tubes just described, a V tube may be used, one limb of which is closed, and contains the prepared foil.

NITRIC ACID.

A number of experiments have been made on the reducing action of occluded hydrogen on nitric acid and other oxygen compounds of nitrogen, and as the action of this gas can be studied on each compound apart from the rest, and as hydrogen in this condition resembles in its action nascent hydrogen, the results may reasonably be expected to throw a little light on the difficult and complicated subject of the action of metals on nitric acid.

A tube of electrolytic hydrogen was kept over nitric acid (sp. gr. 1·42) for six weeks; there was not, however, the least sign of any absorption. Similar tubes were kept for several months over acid somewhat more diluted than this, but no contraction of the volume of gas was noted in any case. This, then, shows the remarkable difference between ordinary or molecular hydrogen and the same element in a nascent state—a difference generally attributed to different atomic aggregation.

Hydrogen in contact with prepared platinum foil acts very readily on nitric acid. With acid of sp. gr. 1·42 red fumes make their appearance almost immediately and attain their maximum in a few minutes; there is then a gradual contraction in the gas, which is not quite absorbed for an hour or two unless the tube be agitated. The acid has by this means acquired a yellow appearance, being evidently reduced to nitrous acid.

With acid more diluted than this the results are similar, but the fumes are less red, and with an acid weaker still no red fumes appear; the action, therefore, is between the hydrogen and vapor of nitric acid.

If the acid (1·42) be diluted with four or five times its volume of water, it is still acted on by hydrogen pretty rapidly, the contraction being from 40 to 50 mm. per hour, depending on the freshness of the platinum black; the resulting acid has a nitrous smell and a reducing action on potassium permanganate. More diluted still, the action is slower, but still there is an action, the lower limit of which I did not determine. With normal acid, however, the action is exceedingly slow; in seven days the contraction was only 30 mm. in one of my experiments; with one-half normal (the

weakest acid used in this mode of experimenting) the action was much the same.

Heat will greatly accelerate the action of hydrogen on dilute acid. For this purpose the tube is filled to the extent of about three-fourths with hydrogen, and either sealed up or closed with a good cork; it must be tied and then placed in a slanting position, so as to expose as much foil as possible to the liquid and gas in the water bath.

Heated in this way with normal acid, the absorption was almost complete in two hours, the acid in the tube giving the reaction for nitrous acid and also indicating a little ammonia with Nessler's reagent.

With half normal acid treated in the same way the result was pretty much the same; less nitrous acid and more ammonia appeared to be produced. With one-eighth normal acid the action was slower, but by six hours' heating in the water bath nearly all the hydrogen had disappeared.

With $\frac{1}{16}$, $\frac{1}{32}$, and $\frac{1}{64}$ normal acid the action was very similar; in from five to eight hours the hydrogen almost or quite disappeared, and the residue in the tube gave in every instance the reactions of nitrous acid and ammonia. No acid more dilute than $\frac{1}{64}$ normal was experimented with.

The action of occluded hydrogen on these dilute solutions of nitric acid is interesting, as showing the activity of hydrogen in this condition; and for the purpose of comparison I have sometimes made an electrolysis of acid of the same strength, using a very weak current. Some of the hydrogen under these conditions will reduce a portion of the acid, but another part of the hydrogen always appears in a free state at the negative pole, showing that the gas in this condition can with difficulty, and only incompletely, reduce acid so dilute, which acid is freely acted on by occluded hydrogen if assisted by a moderate heat.

NITRATES.

The nitrates are all reduced by occluded hydrogen, but the action is not quite so rapid as with some other solutions. Hydrogen standing over a saturated solution of potassium nitrate was absorbed to the extent of 25 c. c. in six days; the solution in the tube smelled of ammonia, and showed that a nitrite had been formed. With sodium nitrate the action was very similar. Hydrogen sealed up in a tube containing platinum with a strong solution of potassium nitrate acted much more rapidly on exposing it to the heat of the water bath. The gas had almost disappeared in two and a half hours, and the solution had a strong smell of ammonia and gave a reaction for a nitrite.

Hydrogen standing in a similar tube without platinum, over a concentrated solution of niter, gave no contraction in one month; and a similar sealed tube exposed to the heat of 100° C. in a water bath for some hours showed no signs of contraction.

Crumpled platinum foil coated with platinum black was placed in a flask and half covered with a solution of KNO_3; when the flask was filled with hydrogen and heated on a water bath, the solution showed in a few minutes an alkaline reaction, and there was an evolution of ammonia. Other nitrates are also reduced. Those of barium and calcium, for instance, are reduced gradually at ordinary temperatures, and much more rapidly at the temperature of boiling water.

Cobalt Nitrate.—Hydrogen (without platinum) stood over a strong solution of cobalt nitrate for some weeks; but there were no signs of absorption. In the presence of coated platinum, however, there was a gradual but slow contraction of the gas. In a week this amounted to a column 150 mm. in height; on the foil there were a few spots of a greenish blue color, and a brownish-yellow flocculent matter deposited. Some of the same solution was sealed up in a tube with hydrogen and heated for one hour (in presence of platinum); at the end of that time all the hydrogen had disappeared.

Nickel Nitrate.—This compound behaves in a similar manner, being slowly acted on at ordinary temperatures, and by two hours' heating in the water bath the action is complete. No action occurs without the platinum.

Lead Nitrate.—When treated in the same manner, this body gave similar results; without the presence of platinum it gave no result, either hot or at ordinary temperatures.

Copper Nitrate.—Russell (*Journ. Chem. Soc.*, xxvii., 3, 1874) states that copper nitrate and some other substances appear to be reduced by hydrogen; no particulars of experiments are, however, recorded. I have kept hydrogen standing over a strong solution of this salt for some weeks without any obvious result; in the presence of platinum, however, the hydrogen is readily absorbed with a production of copper nitrite, apparently. (In one of my experiments a slight deposit of metallic copper seemed to be formed on the platinum foil, but this is not always the case.) *Nitrates of mercury* and *bismuth* are acted on by occluded hydrogen.

Silver Nitrate.—Chemists are by no means unanimous as to the action of hydrogen on silver nitrate. A diluted solution of this salt is readily reduced by occluded hydrogen to a metallic state, small, brilliant-looking crystals making their appearance on the foil. The action with platinum was about ten times as rapid as without, with a dilute solution; with a concentrated one the difference is not so marked. I did not see any reduction to nitrite mentioned by Russell in the paper above alluded to, but the reduction did not, I expect, go far enough to produce this salt.

From these experiments it appears that all nitrates are readily reduced by occluded hydrogen.

CHLORINE, BROMINE, AND IODINE.

Chlorine in the dark does not, as is well known, combine with hydrogen. I kept a tube of hydrogen standing over chlorine water for seven days, but there was not the slightest contraction. In the presence of platinum, however, the contraction is at the rate of 50 or 60 mm. per hour; but with chlorine and bromine the finely divided platinum is liable to become detached from the foil, and hence the action, after a time, becomes slower.

Hypochlorous acid is reduced by hydrogen under the usual conditions of experiment.

Hydrogen standing over a saturated solution of $KClO_3$ showed no contraction in six weeks. In the presence of the prepared foil the action is fairly rapid, being at the rate of 10 mm. per hour. The chlorate is reduced to chloride; a quantitative experiment accounted for all the hydrogen absorbed.

Potassium perchlorate is not acted on.

Bromine water acts pretty much the same as chlorine. Iodine in a solution of potassium iodide is acted on more slowly.

Bromates and iodates were not experimented with.

CONCENTRATED SULPHURIC ACID.

It is sometimes stated in text books that hydrogen attacks concentrated sulphuric acid; *e. g.*, in Frankland's and Japp's *Inorganic Chemistry* the following note occurs: "The use of concentrated sulphuric acid as a desiccating agent ought to be avoided if a very pure gas (hydrogen) is required, as hydrogen slowly reduces this acid in the cold, with formation of sulphurous anhydride." In order to test this, I kept pure hydrogen over pure concentrated sulphuric acid for three weeks. There was no sign of contraction, and the acid had no smell of SO_2, and not the least reducing action on potassium permanganate. The reducing action of hydrogen on this acid must therefore be extremely small to exhibit no action in three weeks, and I cannot help thinking that one might safely dry hydrogen by means of sulphuric acid, provided the gas be pure; should it contain sulphureted or phosphureted hydrogen, it would be quite another matter.

In contact with prepared foil the action is very different. There is a steady but slow absorption, which amounted to 150 mm. in three days. The acid, when examined, smelt strongly of SO_2, and had a reducing action on potassium permanganate.

Hydrogen reduces H_2SO_3, but the action is slow.

PERMANGANATES.

Potassium permanganate is slowly reduced by hydrogen, but the action is very slow; in the presence of platinum it is much hastened; but even in this case it is slower than one would have expected, the upper surface of the foil soon becoming exhausted unless agitated.

BICHROMATES.

An acidulated solution of potassic bichromate was not reduced by hydrogen in six weeks without platinum; with platinum the action is steady and fairly rapid.

FERRIC SALTS.

Ferric salts are not reduced by prolonged contact with hydrogen. In presence of platinum ferric chloride is readily reduced, and the reduction proceeds with great regularity; if the platinum deposit be fresh, the contraction will amount to 50 or 60 mm. per hour. The greater regularity shown in the reduction of this salt, compared with some others, is owing no doubt to its solubility, thus preventing the upper layer from becoming exhausted.

Ferric sulphate is very readily reduced by hydrogen in presence of platinum. In my experiment the action seemed a little more rapid than with the chloride.

Warren (*Chemical News*, vol. lv., p. 49) has suggested the use of ferric salts instead of potassium bichromate as a fluid for the galvanic battery. I know nothing of its efficiency for that purpose, but in my experiments a concentrated solution was more readily reduced than the acidified bichromate.

MERCURIC SALTS.

Mercuric chloride was not reduced by hydrogen alone in six months. With platinum it rose 75 mm. in twelve hours, and a crust of white powder (Hg_2Cl_2) coated the foil. After a time the action became much slower from exhaustion of the upper layer.

PLATINUM SALTS.

Platinum chloride is slowly reduced by hydrogen alone in the cold. The presence of the prepared foil greatly accelerates the action, which is as great in one hour with the foil as in forty-eight hours without it. The upper layer is completely reduced, becoming quite colorless.

FERRICYANIDES.

Hydrogen standing over potassium ferricyanide was reduced by 15 mm. in twelve months; with the foil it is pretty readily reduced to ferrocyanide.

ACTION OF HYDROGEN ON NITRIC OXIDE IN PRESENCE OF PLATINUM.

Although this paper deals chiefly with the reducing action of hydrogen, it may not be out of place to mention here a few experiments with nitric oxide and hydrogen. The subject is by no means a new one. Most chemical works record the fact that hydrogen and nitric oxide give rise to ammonia when led over gently warmed spongy platinum, and the reducing action of nascent hydrogen on the same gas is employed in preparing hydroxylamine. The method I have adopted in studying the reducing action of hydrogen seemed suited also to investigate the action of gases on each other, inasmuch as the residual gases can be readily measured and examined. I have made a great number of experiments with these gases, and some of the results seem worth recording.

The experiments were, for the most part, made in the same tubes I have already described, some experiments on a much larger scale. In some cases the experiments were made over mercury, generally over water. One volume of hydrogen and two volumes of nitric oxide standing over mercury gave a very regular action, and the results of the different experiments were constant and represented by the equation $2NO + H_2 = N_2O + H_2O$. (Although standing over mercury, the gases were moist, as the tube was first filled with water, over which the mixed gases were collected. If the tube had been filled with mercury, the finely divided platinum would have amalgamated with the mercury and so lost its activity.) Equal volumes of nitric oxide and hydrogen, treated in the same way, gave a contraction equal to one half the original volume, the residue being nitrogen.

Made over water, the results are pretty much the same; on the whole they are, perhaps, a little less regular, due, no doubt, to the solution of a little of the nitrous oxide in the water.

With a larger proportion of hydrogen the action is much more rapid, taking place in the course of a few minutes if the platinum is pretty active, and leaving a strongly alkaline residue. Similar experiments made on a larger scale gave very interesting results.

Hydrogen to the extent of 600 c. c. was collected in a cylinder, in the upper part of which a large piece of platinum foil was placed; 150 c. c. of nitric acid were added rapidly. There was an almost immediate action—first the water in the cylinder was somewhat depressed, and heavy whitish fumes appeared near the foil; there was then a pretty rapid contraction of the gas, till only 300 c. c. remained, 450 c. c. having disappeared. This action only took a few minutes, and considerable heat was developed during the change. The residue was chiefly hydrogen, but it contained a little nitrogen; all the nitric oxide had disappeared, and there was no nitrous oxide in the residue. The liquid was strongly alkaline, and gave the reaction for hydroxylamine.

Similar experiments have been made with like results, and the contraction is very often the same as the above, though sometimes it may be a little less.

Ammonia is formed at the same time, and the change might be represented as follows:

$$2NO + 8H = NH_4O + NH_4HO.$$

This, however, does not account for the small amount of nitrogen resulting from the experiment. This is a very interesting reaction, but by no means an unexpected one, seeing that hydroxylamine is prepared by the action of nascent hydrogen on nitric oxide.

If the nitric oxide is added in a much smaller proportion than was used in the last mentioned experiment (viz., 1 to 4 hydrogen), the action appears pretty much the same, but much slower; for instance, I added to 600 c. c. of hydrogen 50 c. c. of NO, and the action was not complete for one hour, when 150 c. c had been absorbed; on adding another 50 c. c. a similar contraction takes place. After a time, however, the contraction is less than that just indicated.

These experiments show the influence of mass in determining chemical change. With a small amount of hydrogen the reduction is to nitrogen and nitrous oxide; when the hydrogen is greater in amount, ammonia and hydroxylamine are the chief products of the reaction.

As in these experiments the nature of the change depends largely on the mass of gases present, I tried the effect of the copper-zinc couple on nitric oxide by placing a piece of zinc in a tube, coating it with copper, and then filling the tube with nitric oxide. The action is not very rapid, and the gas left is from one-fourth to one-third of the nitric oxide taken; ammonia and a little hydroxylamine are formed.

In this case, therefore, the hydrogen is to some extent capable of uniting with the nitrogen, but not nearly to the extent that it does when there is a large mass of hydrogen in presence of platinum.

In presence of platinum, nitric oxide is reduced by carbonic oxide, forming nitrous oxide or nitrogen, according to the quantity of CO present.

Nitric oxide is also reduced by ammonia in presence of platinum. Nitrous oxide is reduced by hydrogen, ammonia, and carbonic oxide in presence of platinum.

In a few experiments, when nitric oxide was mixed with the smaller proportions of hydrogen mentioned, there were slight indications of hyponitrous acid; in other cases, however, no trace of this body could be obtained. If this substance is formed, I believe its formation depends on the activity of the platinum.

These experiments may be considered as proving that hydrogen, in presence of finely divided platinum, possesses all the properties of nascent hydrogen. In many cases the action is slow, but in some it might perhaps be used as a means of reduction when the presence of sodium-amalgam or the copper-zinc couple is objectionable.—*Glasgow Philosophical Transactions.*

SCIENTIFIC DEVELOPMENT OF THE PHOTOGRAPHIC IMAGE.*

By John Carbutt.

At the solicitation of our president for a practical paper to be read at the convention, I have selected the subject, "Development of the Photographic Image." I have been impressed when examining the work of different photographers that much of it would have been greatly improved had the plate had treatment in developing suited to the subject and lighting. There are photographers who make the study of the developing of a plate of as much importance as the lighting of the subject, and it is by such that we find produced the highest results in photography.

You may take the most perfect plate sent out by the dry plate maker, and religiously follow his formula for development, but, unless your own judgment is largely made use of in so preparing the developer as to suit the subject, the most mediocre result may be produced. Strength of alkaline solution and temperature at time of using are largely the controlling factors to a successfully developed negative. The photographer may arrange the most artistic pose and lighting, and produce but a poor result photographically by unskillful use of his developer, and he most likely blames the plate maker for the poor quality of his negative.

The fixed alkalies, potassium carbonate and soda carbonate in combination with soda sulphite, are those most in use by American photographers in forming a pyro developer. Of the two alkalies, the soda carbonate has my preference, especially in summer time. By compounding a stock alkaline solution in the following manner, it becomes a matter of extreme simplicity to form a developer suited to the lighting and subject in hand:

Soda sulphite, crystals	2 parts.
Soda carbonate, crystals	2 "
Water (warm)	10 "

This when cooled to a temperature of from sixty to sixty-five degrees, Fahrenheit, will be found to test twenty degrees with Baume's hydrometer. By dilution with water to one of the three following strengths, a developer can be formed more suitable to the subject than by using one strength of alkali, as is commonly done:

One part of stock solution to five parts of water weighs	3½° Baume.
One part of stock solution to eight parts of water weighs	2° "
One part of stock solution to ten parts of water weighs	1½° "

The solution of one to ten may be considered a weak solution, the one to five strong, and the one to eight medium. To any one of these may be added pyro, dry or in solution, in the proportion of from one to three

* Read at the Minneapolis convention, July, 1888.

grains to the ounce. It will be well to bear in mind that the slower and more vigorous working plate requires a developer stronger in alkali and weaker in pyro, and the reverse for a highly sensitive plate. For a subject in light colors, as drapery, I recommend the one to ten alkali solution with one and one-half grains of dry pyro or one-half drachm of a pyro solution one in sixteen, and one or two drops of a solution of bromide of sodium or potassium, one to ten, not bromide of ammonium. For the general run of subjects having dark or mixed colors, the one to eight alkali with from one and one-half to two and one-half grains of pyro to the ounce forms a generally useful developer. For dark colors in drapery and complexion, the one to five alkali will be most serviceable.

In conclusion I would say that a full exposure, a weak alkali, and a little bromide to the pyro are conducive to well modulated negatives; whereas a strong alkaline solution gives a flat and gray negative, lacking good printing qualities.

THE RUSTING OF IRON.

ON THE CHEMICAL PROCESSES INVOLVED IN THE RUSTING OF IRON.*

By Professor A. CRUM BROWN, F.R.SS.L. and E., Edinburgh.

IN this short paper there is, so far as I know, no new fact described. I believe everything, or nearly everything, in it is to be found in the records of chemical research; but as I find that the process involved in the rusting of iron is often misunderstood, I have thought it might be worth while to put together the known facts in their connection. My attention was first called to the subject by observing what happens when a drop of rain falls on a clean bright surface of iron. At first, for a short time, the drop remains clear, and the bright surface of the iron is seen through it; but soon a greenish precipitate forms in the drop, and this rapidly becomes reddish brown. The brown precipitate does not adhere to the iron, but is suspended in the water, and becomes a loosely adherent coating only when the water has evaporated.

I may premise that, in speaking of rusting, I mean the formation of rust on the surface of metallic iron exposed to ordinary atmospheric conditions. I do not intend to treat of the corrosion of iron by substances such as sulphuric or sulphurous acid, hydrochloric acid, or any other occasional impurities which may be present in air.

In has been conclusively shown that the necessary conditions for the production of rust are: (1) metallic iron; (2) liquid water; (3) oxygen; and (4) carbonic acid, both the latter being dissolved in the liquid water.

Iron remains quite free from rust in an atmosphere containing oxygen, carbonic acid, and water vapor, so long as the water vapor does not condense as liquid water on the surface of the iron.

Let us consider now the action on iron of the three substances, liquid water, oxygen, carbonic acid, singly, and then two and two.

Liquid water, quite free from dissolved gases, does not act on iron at ordinary temperatures. At high temperatures, very rapidly at a red heat, iron is oxidized by water or water vapor, and is converted into the magnetic oxide of iron. This magnetic oxide is formed on the surface of the iron as an adherent coating, and only when it is detached can the water gain access to lower layers of the iron.

Oxygen gas alone does not act at ordinary temperatures on iron. At high temperatures it also converts the iron into the magnetic oxide, which forms an adherent coating.

The same is the case with carbonic acid gas, acting alone. At ordinary temperatures it is without action. At high temperatures the carbonic acid is reduced to carbonic oxide, and the iron is oxidized to magnetic oxide, which forms an adherent coating.

Liquid water with oxygen dissolved in it does not act at ordinary temperatures on iron. This is shown by the fact that ordinary water, exposed to the air, does not rust iron if the water contains a substance, such as lime or caustic alkali, capable of combining with carbonic acid and itself without action on iron. As long as the lime or caustic alkali is there, no rusting occurs. When the lime or caustic alkali has been converted by the carbonic acid of the air into carbonate, then, and not till then, can the carbonic acid of the air dissolve as such in the water, and then, and not till then, does rusting begin.

Water containing carbonic acid dissolved in it acts on iron at ordinary temperatures, forming ferrous carbonate, which dissolves in the carbonic acid water, forming, no doubt, ferrous bicarbonate. In this way artificial chalybeate water has been prepared by shaking up finely divided iron with carbonic acid water. In this action hydrogen gas is given off. Solutions have been thus prepared containing nearly one-tenth per cent of iron. If oxygen is present dissolved in the water, it will unite with the nascent hydrogen; and if we have sufficient water, iron, and carbonic acid, the whole of the dissolved oxygen will be thus consumed. The presence of dissolved oxygen quickens the solution of the iron, the tendency of the oxygen to combine with the nascent hydrogen supplying an additional motive to the action. Probably in ordinary rusting no hydrogen actually becomes free, as under ordinary conditions there will always be enough dissolved oxygen to convert all the nascent hydrogen into water.

When a solution of ferrous bicarbonate is exposed to an atmosphere containing neither free oxygen nor carbonic acid, it loses carbonic acid, and insoluble ferrous carbonate is precipitated. If free oxygen is present in the atmosphere to which it is exposed, the ferrous carbonate is oxidized to ferric hydrate, carbonic acid being given off. This, if the water is not already saturated with carbonic acid, dissolves in the water.

We can now follow the whole process of rusting, and divide it into stages—these stages being really separable, if we take proper precautions, but in the usual case overlapping one another.

We have, 1st, the formation of soluble ferrous bicarbonate; 2d, the conversion of ferrous bicarbonate into ferric hydrate, the white ferrous carbonate passing through green and black intermediate substances into the reddish brown ferric hydrate, *i. e.*, rust.

* Paper read before the Iron and Steel Institute, at Edinburgh.

We have to note that the carbonic acid dissolved in the liquid water, which is necessary for the process of rusting, is not used up in the process. It is given off during the oxidation of the ferrous bicarbonate to ferric hydrate, and is thus ready to act on the new surface of the metallic iron. The continuation of the process of rusting is not, therefore, dependent on new carbonic acid absorbed from the air, but the original carbonic acid, if not removed, can carry on the process indefinitely, as long as liquid water is present, and oxygen is supplied from the air. Once the process is started, it goes on more rapidly, because the porous rust not only does not protect the iron, but favors, by its hygroscopic character, the condensation of water vapor from the air as liquid water. A piece of iron, therefore, which has begun to rust, will continue rusting in an atmosphere not saturated with water vapor, an atmosphere in which a piece of clean iron will not rust, because liquid water will condense from such an atmosphere on the hygroscopic rust, but not on the bright iron.

THE VARIABLE STAR ALGOL.

FOR STAR GAZERS.

THE SCIENTIFIC AMERICAN again presents to its wide circle of readers a table for each of the four divisions of standard time of the dates upon which the eclipses of the variable star Algol may be observed during the season of 1888-89. Although these eclipses occur with the greatest regularity in periods of about three days, there being one hundred and twenty-seven of them during the year, yet it is only between September and February that they can be conveniently observed in the evening hours. The subjoined table gives the date to the nearest minute for the middle of every eclipse occurring between 5 P. M. and 2 A. M. from the last of September to the middle of February. It should be remembered that when an eclipse is given in the tables as occurring A. M., its beginning must be looked for on the evening of the day before.

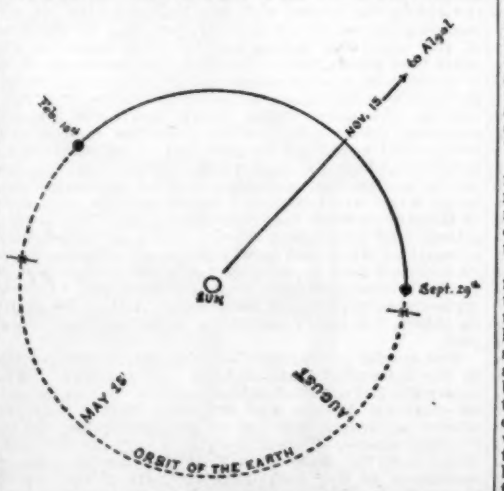
This singular star, the most conspicuous and interesting of all the variable stars, was the subject of an extended article in the SCIENTIFIC AMERICAN SUPPLEMENT two years ago, and its curious changes have been since watched by a large number of our readers, to whom this table will be useful.

DATES OF MINIMA OF ALGOL, 1888-1889.

Standard Time.

EASTERN.	CENTRAL.	MOUNTAIN.	PACIFIC.
SEPTEMBER.			
29th, 1:38 A. M.	29th, 0:38 A. M.	28th, 11:38 P. M.	28th, 10:38 P. M.
OCTOBER.			
1st, 10:27 P. M.	1st, 9:27 P. M.	1st, 8:27 P. M.	1st, 7:27 P. M.
4th, 7:15 P. M.	4th, 6:15 P. M.	4th, 5:15 P. M.	
19th, 3:18 A. M.	19th, 2:18 A. M.	19th, 1:18 A. M.	19th, 0:18 A. M.
22d, 0:7 A. M.	21st, 11:7 P. M.	21st, 10:7 P. M.	21st, 9:7 P. M.
24th, 8:56 P. M.	24th, 7:56 P. M.	24th, 6:56 P. M.	24th, 5:56 P. M.
27th, 5:44 P. M.	27th, 4:44 P. M.		
NOVEMBER.			
			8th, 2:9 A. M.
11th, 1:49 A. M.	11th, 0:49 A. M.	10th, 11:49 P. M.	10th, 10:49 P. M.
13th, 10:38 P. M.	13th, 9:38 P. M.	13th, 8:38 P. M.	13th, 7:38 P. M.
16th, 7:27 P. M.	16th, 6:27 P. M.	16th, 5:27 P. M.	
DECEMBER.			
		1st, 1:30 A. M.	1st, 0:30 A. M.
4th, 0:19 A. M.	3d, 11:19 P. M.	3d, 10:19 P. M.	3d, 9:19 P. M.
6th, 9:8 P. M.	6th, 8:8 P. M.	6th, 7:8 P. M.	6th, 6:8 P. M.
9th, 5:57 P. M.	9th, 4:57 P. M.		
24th, 2:3 A. M.	24th, 1:3 A. M.	24th, 0:3 A. M.	23d, 11:3 P. M.
26th, 10:51 P. M.	26th, 9:51 P. M.	26th, 8:51 P. M.	26th, 7:51 P. M.
29th, 7:40 P. M.	29th, 6:40 P. M.	29th, 5:40 P. M.	
JANUARY, 1889.			
13th, 3:47 A. M.	13th, 2:47 A. M.	13th, 1:47 A. M.	13th, 0:47 A. M.
16th, 0:36 A. M.	15th, 11:36 P. M.	15th, 10:36 P. M.	15th, 9:36 P. M.
18th, 9:25 P. M.	18th, 8:25 P. M.	18th, 7:25 P. M.	18th, 6:25 P. M.
21st, 6:14 P. M.	21st, 5:14 P. M.		
FEBRUARY.			
5th, 2:20 A. M.	5th, 1:20 A. M.	5th, 0:20 A. M.	4th, 11:20 P. M.
7th, 11:9 P. M.	7th, 10:9 P. M.	7th, 9:9 P. M.	7th, 8:9 P. M.
10th, 7:58 P. M.	10th, 6:58 P. M.	10th, 5:58 P. M.	

During the half hour on each side of the minimum, the change of light is so slight that it is very difficult to determine the moment when the star is most obscured, and its period, that is, the time from one eclipse to another, has been the subject of investigation by a great many eminent astronomers. About a century ago, Goodericke ascertained it to be 2 days 20 hours 48 minutes and 59 seconds. Since then it has



fluctuated, decreasing and increasing, according to some unknown law, a few seconds, until now the seconds are 51. The above table does not show this period exactly, unless it were carried out for the whole year. The reason of this will be seen by an inspection of the diagram showing the orbit of the earth, which is placed upon it in the two extreme dates of the table, the travel of the earth between those dates being drawn with a full line. When the earth reaches the point marked Nov. 15, it is at that point in its orbit when it is nearest to the star, and it is evident that between Sept. 29 and Nov. 15, it is moving toward Algol, and that each eclipse will be observed a little before the calculated time, and the periods will be shorter than 2 days 20 hours 48 minutes 51 seconds. But after passing that point, the earth moves away from the star, and its obscured light will each time be longer in catching the earth on its way round. Taking the whole orbit into consideration, and starting with the date of an eclipse of Algol observed in the middle of November, it will take about 15½ minutes longer than the calculated time to reach the earth when at the opposite side of the orbit in the middle of May. This amount is of course made up during the progress of the earth on the other half of the orbit from May to November. This inequality of period is, as is evident from the inspection of the diagrams, greatest about the middle of February and August. At those times the earth is traveling either from or toward the star at the rate of about 4½ millions of miles in each of Algol's periods of nearly three days. To make up this difference the light has to travel for about 23 seconds longer in February, when the earth is moving away from the star, and meets the earth 23 seconds sooner in August, when the earth is moving toward Algol.

Algol may be identified by drawing a line from the Pleiades northward to the zigzag line of stars that so conspicuously marks the constellation of Cassiopeia, and will be found about half way upon such a line. For a more exact means of identification, the reader can consult the star map in the SCIENTIFIC AMERICAN SUPPLEMENT of Sept. 11, 1886, in which may be found an account, with illustrations, of that theory of Algol's variations which is now generally accepted by astronomers.

LAKE WARREN.

AT the recent meeting of the American Association, geologists from numerous States were present; but Cleveland being situated on the great lakes, the theory of their origin and the glacial period in general chiefly attracted the attention of the meeting. This was principally the case when J. W. Spencer read his interesting series of papers on Lake Warren and its later history. The following is from *Science:*

Lake Warren is the first chapter in the history of the great lakes, and is subsequent to the deposit of the upper bowlder clay, and therefore the lakes are all very new in point of geological time. By the movements of the warpings of the earth's crust, as shown in the beaches—after the deposit of the later bowlder clay—the lake region was reduced to sea level, and there were no Canadian highlands northward of the great lakes. Upon the subsequent elevations of the continent, beaches were made around the rising islands. With the rising of the land, barriers were brought up about this lake region, producing Lake Warren—a name given to the sheet of water covering the basin of all the great lakes. A succession of beaches of this lake have been partially worked out in Canada, Michigan, Ohio, Pennsylvania, and New York, covering almost thousands of miles. Everywhere the differential uplift has increased from almost zero about the western end of the Erie basin to three, five, and in the higher beaches to from five to nine, feet per mile. With the successive elevations of the land, this lake became dismembered, and the present lakes had their birth. The idea that these beaches in Ohio and Michigan were held in by glacial dams to the northward is disproved by the occurrence of open water and beaches to the north, which belong to the same series, and by the fact that outlets existed where placid dams are required.

With the continental rise described above, owing to the land rising more rapidly to the northeast, Lake Warren became dismembered, and Huron, Michigan, and Superior formed one lake; the Erie really was lifted out of the bed of Lake Warren, and became drained; and Ontario remained at a lower level. The outlet of this lake was southeast of Georgian Bay by way of the Trent valley into Lake Ontario at about sixty miles west of the present outlet of this lake. The waters of this upper lake were twenty-six feet over this outlet into the Trent valley, and long continued to flow through a channel from one to two miles wide; and it has cut across a drift ridge to a depth of five hundred feet, as the whole area has been rising. With the continued continental uplift to the northeast (which has raised the old beach at the outlet about three hundred feet above the present surface of Lake Huron), the waters were backed southward, and overflowed into the Michigan basin and into the Erie, thus making the Erie outlet of the upper lakes to be of recent date. This is proved by the fact that the Georgian beach, which marked the old surface plain of the upper great lake, descends to the present water level at the southern end of Lake Huron, and is beneath the surface of the water upon its northwestern side, as the uplift, which has been measured, was to the northeast.

The Erie basin is very shallow, and, upon the dismemberment of Lake Warren, was drained by the newly constructed Niagara River. Subsequently the northeastward warping eventually lifted up the rocky outlet, and formed Erie into a lake in recent times, thus making it the youngest of all the lakes.

Previous investigations have shown that there was a former river draining the Erie basin, and flowing into the extreme western end of Lake Ontario, and thence to the east of Oswego, but no further traceable, as the lake bottom rose to the northeast. Upon the southern side there were a series of escarpments, some of which are now submerged. By recent studies of the elevated beaches, it is demonstrated that the disappearance of this valley is due to subsequent warpings of the earth's crust, and that the valley of the St. Lawrence was one with that of Lake Ontario. Recent discoveries show that the ancient St. Lawrence, during the period of high continental elevation, rose in Lake Michigan, flowed across Lake Huron and down Georgian Bay, and a drift filled the channel to Lake Ontario, thence by the present water to the sea, receiving on its way the ancient drainage of the Erie basin and other valleys.

The Huron and Ontario basins are thus sections of the former great St. Lawrence valley, which was

bounded, especially upon the southern side, by high and precipitous escarpments, some of which are submerged. But upon their northern sides there are also lesser vertical escarpments, now submerged, with walls facing the old valley. The valley was excavated when the continent was at high altitude, for the eastern portion stood at least two hundred feet higher than at present, as shown by the channels in the lower St. Lawrence, in Hudson Strait, and in the New York and Chesapeake bays. The valley was obstructed in part by drift and in part by a north and northeastward differential elevation of the earth's surface due to internal movements. The measurable amount of warping defied investigation until recently, but now it is measured by the amount of uplift of beaches and sea cliffs. Only one other explanation of the origin of the basins has been given—the "erosion by glaciers." The foundation of this theory is that the glaciers are considered (by some) to erode. A theory of this kind was a necessity, so long as the terrestrial warping was not known.

Living glaciers, however, abrade, but do not erode, hard rocks; and both modern and extinct glaciers are known to have flowed over even loose morasses and gravels. Again, even although glaciers were capable of great plowing action, they did not affect the lake valleys, as the glaciation of the surface rocks shows the movement to have been at angles (from 15° to 90°) to the direction of the side of the vertical escarpments against which the movement occurred; also the vertical faces of the escarpments are not smoothed off as are the faces of Alpine valleys, down which glaciers have passed. Lastly, the warping of the earth's surface in the lake region since the beach episode after the deposit of the drift proper is sufficient to account for all rocky barriers which may obstruct the basins.

These papers were followed by an interesting discussion, in which many prominent geologists took part.

THE MEANS EMPLOYED BY BUTTERFLIES OF THE GENUS BASILARCHIA FOR THE PERPETUATION OF THE SPECIES.

By SAMUEL HUBBARD SCUDDER, Cambridge, Mass.

THE power of reproduction conceded, the universal instinct for self-preservation is the fundamental and controlling principle by which the perpetuation of any kind of animal is successfully reached. The uncontrollable maternal instinct of self-sacrifice existing in some animals alone overmasters it, and this exists only in the higher animals, which, compared with the great mass, are but few in number; and is then in most cases called into play only when the creature's life-work is nearly finished. No such instinct occurs among butterflies, nor is in any way likely to be found, so that "self-preservation" and "perpetuation of the species" are here, at least through all but the closing days of life, practically equivalent terms. The "struggle for existence" in the species and in the individual are largely convertible terms.

This struggle is the perpetual inheritance of the individual. The individual inherits alike its structure and its habits of life, which latter are very largely, perhaps almost absolutely, dependent on its structure; its taste and its propensities, its fears and its devices to circumvent its enemies; all its instincts, which are, to a great extent, possibly wholly, the entailment of ancestral habits; its very attitudes, whether at rest or in motion. Its advantages and its disadvantages are thus alike its legacy; so too the peculiar means it employs to disembarrass itself of these disadvantages. This is especially and more immediately true of the insect in its earlier stages, where freedom to change the immediate surroundings is exceedingly limited or altogether impossible, except so far as there is foresight, or an instinct marvelously akin to foresight, on the part of the creature in an antecedent stage.

It is of more than usual interest to study the means of self-preservation in the genus *Basilarchia* since there is hardly another genus of butterflies where throughout its entire life the insect is apparently so exposed to its enemies. They are all, of their kind, conspicuous objects even to our dull eyes, and, more than that, they are, with the exception of the chrysalis, always found in unusually conspicuous situations. How then do they manage to escape their keen-sighted foes, the birds, or their wakeful, indefatigable, persistent enemies among the insect tribes—ichneumons, ants, wasps, flies, mites, and spiders?

Take first the egg stage. Every one who has attempted to rear butterflies knows what immense destruction falls to the lot of any species at this stage in its life. Ants and spiders look on them as delicacies made for their delectation, and there is a whole group of tiny *Hymenoptera*, almost too small to breathe, one would think, mere specks, which live solely upon insects' eggs, piercing them with their egg darts, their progeny living imprisoned and feeding on the contents until they have run the cycle of their changes. Some attack whole batches of eggs, laying one egg in each, so that one parasite may destroy the entire brood of one butterfly; others lay their all in one or two eggs, and it is to this class that those belong which sting the eggs of *Basilarchia*. How does *Basilarchia* escape this danger? In the first place, the mother rarely lays more than one egg in one spot or even on one bush, though as many as a dozen or two may occasionally be found, where the butterflies' numbers are great and they are growing as it were imprudent. Then it must be remembered, first, that—to judge from the latest researches—these parasitic flies must be guided less by vision than by touch; and second, that most insect eggs are laid on the broader parts of the leaf on which the young will feed; it is here that the parasite will range in quest of prey; but the eggs of *Basilarchia* are rarely found except at the extreme tips of leaves, and in addition the leaves of the food plants concerned are all acuminate, some to an excessive extent, as in some of the poplars and birches. When the parasite has, however, found an egg, it may well be inquired whether she would not be deceived by it. It differs from the eggs of all our other butterflies, in that it is besprinkled with little flexible filaments for all the world like the hairs of some leaves. Or if the clothing of the eggs did not deceive, she might even then find it difficult of attack, for minute as these parasites are, less than half a millimeter long, their bodies would extend across at least three of the polygonal cells which regularly stud the surface of the egg, and which send forth these little filaments at every angle, so that poor bewildered madame must struggle through a weary chapparal before she can attain the barren grounds at the summit and find a spot to readily insert her sting. Yet that she succeeds is only too evident to the collector; the larger part of the eggs obtained in the open field which have fallen into my hands have been parasitized.

This is its but too partial defense against its special enemies. But how about those wandering buccaneers the ants, mites, and spiders? These labor under the same visual defects as the direct parasites, or sometimes greater ones, and the position of the egg, remote from their usual hunting ground, must serve as no inconsiderable protection; how great, there are hardly means of measurement. Their greatest protection from these savages, which cannot fly, but must wander ceaselessly about on foot in search of prey with satanic energy, is undoubtedly in the fewness of their number on one plant. The spider that finds two eggs of a *Basilarchia* in one day must be an excellent hunter.

Escaped at last from these dangers, which only lasted at the most ten days, the caterpillar crawls forth from its prison and begins its active life. It is a scrawny, juiceless-looking thing, all covered with warts, and less than any other newly born caterpillar would seem a tempting morsel even to an ichneumon or a spider. Yet both make havoc with it at this time. To a wandering ichneumon, contact with an empty egg shell would probably mean, as a result of its inherited wisdom, that some nice young caterpillar was about, and the neighborhood would be all the more thoroughly ransacked. Caterpillars devouring their egg shells, and so not leaving this "scent" behind them, would oftenest escape, and by degrees this habit would be perpetuated and fixed; and so it is here; almost invariably the caterpillar hastens to destroy its former prison walls, which it devours to the very base, too closely glued to the leaf to be eaten; probably it breathes more freely when that is done.

But where does it now find itself? Its food at its very feet—yes; but in the most exposed position possible. Atop the extreme tip of one of the outmost leaves of a spray that projects most freely into the sun and air, just where it can most easily be seen by the passer-by; this seems to be the case nine times out of ten. It is, however, probably the safest place from the prowling spiders; but surely not from its flying enemies. What does it do? Retreat down the leaf? That would be only to exchange one danger for another, and on its way to a presumed place of safety it would be more sure of detection, because a moving object in nature is always most easily noticed. No; it eats the nearest bit of leaf down to, but not including, the midrib, first on one side and then on the other, and then retires to near the tip of the midrib to digest it; subsequent meals it takes in the same way, moving with excessive deliberation along its narrow path and retiring always to the same spot. On this perch it cannot be seen from below, and from the sides and above seems almost or wholly a part of the denuded midrib to which it clings; more particularly when the leaves are in motion by the wind, as they usually are on the trees on which it feeds, particularly in the case of the aspen.

That this mode of life is on the whole an advantage to it is rendered probable from the fact that there are two cases known in which it is followed very closely by caterpillars of a moth (*Notodonta*) feeding on the very same plant as species of butterflies with this habit (one in Europe and one in America); while the caterpillars of *Basilarchia* employ a further device, the actual import of which has been a puzzle. Very soon after birth, when it has eaten but a very few swaths down the leaf, the little fellow constructs a small and loose packet from minute bits of leaf and other rejectamenta, loosely fastened to one another and to the midrib, close to but scarcely touching the eaten edge of the leaf, and as fast as the leaf is eaten, it removes this packet (continually added to until it becomes about as big as a small pea), farther and farther down the midrib away from its perch, always keeping it near the eaten edge. It should be noted that it is so loosely attached, the bits of leaf at all possible angles, that it is moved by the least breath. Meanwhile the caterpillar has been growing larger and more conspicuous, and thus in greater peril from its enemies. There are two possible services that this odd packet may render. A spider wandering over the leaf and observing its motion may seize it, and, thinking it has a prize, hurry away with it and leave its architect unharmed. This seems to me rather a strained suggestion, for a wandering spider would probaby proceed to investigate it on the spot. Another explanation seems more probable. It should be remembered that the leaves preferred by these creatures as food are mostly such as are easily shaken by the wind, and as the caterpillar moves with the leaf and with all surrounding leaves, in a continual fluttering in the case of the trembling aspen, and to a less degree in the other food plants, this, of itself, is a protection to it, as it would more readily escape observation as an object distinct from the leaves, all being in motion together; but on the more stable leaves, like the willow and especially the *Rosaceæ* and the oaks, the motion in a feeble wind would not be sufficient to be serviceable, and here at least the packet comes into play. An object in motion among others at rest is a most noticeable thing, a fact well recognized among animals, as a host of them show when they fear being seen. This packet attached by loose silken threads moves, as stated, with a breath of wind, and so would distract attention from its architect near by, who has taken pains to place it at the farthest remove from its perch, while still (to avoid undesirable steps) on its daily track. If this be really its object, it is surely one of the oddest devices in nature.

The species of *Basilarchia* all pass the winter while in the caterpillar state and but partly grown. The caterpillar has moulted at least once (devouring its cast-off clothing, by the way, doubtless that it may not attract attention), and has to prepare against the inclement season. This it does in a very shrewd way, which is all the more remarkable because no trace or semblance of it is seen in caterpillars of the broods that attain their entire growth in the same season. When the proper time approaches, warned thereto possibly by the dryness of its food, or by the cooler nights, the caterpillar constructs a little nest, sometimes from the still unfinished leaf on which it was born, sometimes from one which it prepares specially at greater pains; this is done by eating away or biting off the unnecessary parts, and leaving on either side of the base of the leaf little flaps just large enough, when drawn together, bottom side up and meeting above, to form a cylinder into which it can squeeze; a projecting shelf is also left beyond the opening, on which it may stand when ready to crawl in, and upon which it may back out in the spring: the whole of the inside and the upper surface of the shelf are then plastered over with a dense coating of brown silk, and the flaps drawn together; more than that, with strangest foresight, the petiole of the leaf is thoroughly fastened to the stem by numberless threads passed carefully and tightly around both; into this cylinder it then crawls head foremost, completely filling the cavity, closing the beveled hinder opening with the sloping tuberculate and sharpened terminal segments, sure to find itself there when the long night of winter is passed. No; not quite sure, for wasps or some other strong predaceous insects will tear this fine castle open and destroy its single occupant. Whether it is an additional safeguard or not, it is an instructive fact that, at least where the winters are most severe, nearly all these hibernacula are made out of leaves so near the ground that the snow covers them with its warming mantle; and what is more, in certain cases they so closely resemble the winter buds and bursting leaves of the new year that they must sometimes deceive their prowling foes of the early spring.

Shortly after it appears again in the spring and has fed on the tender buds and just opening leaves, it moults again, usually upon the shelf of its hibernaculum, but no longer devours its skin, as it quits the immediate neighborhood. It now changes its livery as well, and is a most extraordinary-looking object, withal very conspicuous. Dark and light green and cream color strive for the mastery, and leave it streaked and blotched, so that it bears no inconsiderable resemblance, in color at least, to the droppings of some birds—a circumstance which doubtless serves it as some sort of protection. Its body is humped, and the bosses bear tubercles which give it a somewhat repulsive aspect; especially a pair a little behind the head are raised aloft thickly studded with prominences, the effect of which is heightened by the creature's habit of arching this part of the body, bending its head to the ground and raising aloft its hinder part, also studded with roughened processes. Altogether it is a rather hideous beast. Then too, if disturbed, it raises the front half of its body from the ground and uses it as a kind of whip-lash, throwing it to one side and the other with great violence. When it walks it moves with a slow and cautious tread, its head trembling as if it had the palsy. All this is doubtless to inspire fear to such enemies as might be tempted to attack it, but to how much avail we can hardly tell. It is certainly attacked in considerable numbers by a parasitic hymenopteron, the young of which live within on the juices of the body and escape from the chrysalis when that is formed.

The chrysalis, helpless thing, probably hangs quite exposed upon the stem of the plant which has given the caterpillar nourishment. We know it almost entirely from those raised in confinement. It has an oddly shaped form with a great projection on the back like a Roman nose, and is of a dark green or greenish brown color, varied with cream color, and smooth as if varnished. This makes it appear like a hanging lump of bird dung, and so again must often prevent its being picked off and devoured by some hungry bird.

When one that has at last escaped all the perils of its youth finally reaches its full development, it is even more conspicuous and exposed than before. Although now upon the wing and no doubt often able to escape a pursuer by some quick movement, its natural flight is not swift, and its ordinary movements on the wing are a few quick flutters, followed by a sailing motion which is most favorable to capture. Its colors differ of course in the different kinds, and they may in this particular be divided into two classes. One affects a deep rich black blue or blackish purple, and is variegated with light blue and white, the latter partly in the form of bands, on some forming a broad bow across both wings, rendering them most conspicuous and striking objects. They are, too, of a pretty large size, and as they fly mostly in the neighborhood of copses or along shaded roadsides or forest roads, they seem to render themselves by the contrasting background as conspicuous as possible. Another class is of an orange brown color of greater or less depth, while the veins are black, and a black stripe, sometimes accompanied by white dots, crosses the wings. These fly in more open places, more fully exposed to the sun, and are scarcely less conspicuous than their fellows. All these butterflies live a considerable time, and indeed the eggs do not mature in the bodies of the females until they have been a fortnight on the wing; and then they do not lay all their eggs at once, or even within a few days, but prolong the operation over many days or even several weeks. To deposit all her eggs therefore, which is the province of course of the female, she must fly amid all the dangers her conspicuous colors offer for about a month—a considerably longer time than the average of butterflies. Previous to egg-laying at least, much of her time is spent upon the ground in company with her fellows, often in great flocks, engrossed in sucking up moisture from the damp earth, from decaying fruits, or the droppings of beasts; and so must become a conspicuous and easy prey to her enemies.

What then is to become of this saving remnant of the tribe? How escape from the dangers which it seems to invite? For the individual there would seem to be nothing but chance; but the number of eggs laid under the most favorable circumstances or chances is very considerable; and if only a pair of these finally reaches maturity and is able to fulfill its functions, the number of individuals of the species is maintained. It would seem, however, as if even this chance were small and as if still further protection were needed. And one further protection is afforded, at least to the orange species, in a peculiarity of their life history. Apparently the species of *Basilarchia* are, at least in New England, normally single-brooded; but in not infrequent cases, doubtless more frequent in southern than in northern parts, a second or supplementary brood is formed in one season; as the butterfly lays eggs for some time, and all the females are not born at once, the earliest progeny of the earliest females may not infrequently be able to mature in the same season in time for the production of a second brood. This would seem to be a provision on the part of nature to give the species a better chance. That they need it is perhaps

evidenced by the fact that the black-veined orange species, which are almost universally more numerous in individuals than the others, have, in regions where one brood is the normal condition of their fellows, always two broods.

But this is not the only advantage the black-veined orange species have, so that we cannot fairly ascribe their greater numbers to this alone. Their very colors are an advantage to them, for in them they mimic species of *Euploeinæ*, which possess a taste and perhaps an odor offensive to birds and other insectivorous animals; the mimicry is very striking indeed, and is the more remarkable from the fact that the northern species resembles the only species of *Euploeinæ* found in the region it inhabits, while the southern species, as well as the southernmost examples of the northern species, resemble another which is more common in the region they inhabit.

It is indeed possible that one of the normally colored species of *Basilarchia*, one that has at least conspicuously contrasted colors, though resplendent with blue and green, is specially protected by the various other devices we have recounted; for certainly it is itself mimicked by one sex of a butterfly of another very distinct group, viz., *Semnopsyche diana.—Psyche.*

THE CHIMPANZEE.

THE Chimpanzee (*Troglodytes niger*) constitutes, along with the orang-outang and gorilla, the group of large anthropomorphic monkeys, and, of the three, appears to be the one that most closely resembles man in its shorter arms and larger brain.

It has long been known to naturalists, all of whom agree in giving Guinea as its native country, although it has been met with also by certain travelers in Gaboon, Congo, and Angola. To these different countries of Equatorial Africa must be added the French colony in Senegal. Since last year two young, six or eight months' old chimpanzees, a male and a female, the latter the older of the two, were captured upon the banks of the Rio Pongo, in Southern Senegal, after their mother had been killed. A photograph of these two young monkeys has been sent to *La Nature* by Dr. Paul Good. It was taken while they were at St. Louis, at the establishment of Mr. Izard, a dealer in animals. This photograph is reproduced in Fig. 1, where the female is shown to the right and the male to the left. Dr. Good had them dressed, and they dined with him, seated upon chairs, like children.

These interesting animals, unfortunately, did not live long. The male died of an abscess of the liver, caused, in all probability, as Dr. Good thinks, by an *Ascaria lumbricoides* which he found in the abscess in the autopsy that he made, and which doubtless penetrated the hepatic organ through the biliary canal. A short time afterward, the female died of grief.

The following are a few details as to this species of monkey.

At the adult age, the chimpanzee measures from 4 to 4½ feet. The natives of Guinea even assert that it finally reaches 5 feet. It is adult at the age of from 10 to 12 years. It has a robust and short body, the belly being prominent; the head is large, with a retreating forehead, with eyes like those of man, and a very flat nose. The jaws are prominent, the upper one bulging, and the lips are thin and very mobile. The chin tapers, the eyes have a red iris and black sclerotic, the eyelids are destitute of lashes, and the orbiter arches are very prominent, and are naked. Fig. 2 shows the face of a chimpanzee that was once owned by the menagerie of the Jardin des Plantes, and Fig. 3 shows the entire figure of an animal seen in profile and walking by the aid of its hands. The arms are strong and reach below the knees. The hands are of medium size and provided with flat nails. The face and palms of the four hands, and often also the back of the same, are naked and of a sun-burned flesh color. The rest of the body is covered with coarse black hair, which is thicker and longer on the head and back and on the extreme surface of the limbs. The forehead, above the orbiter arches, likewise is covered with hair, and the cheeks are hidden by thick whiskers. The chin is covered with large whitish downy hairs simulating a sort of short beard.

The orang-outang is nearly of the same stature as the chimpanzee, from which it differs in its larger arms, its bright red hair, and in its forehead being entirely naked as far as to the top of the head. Finally, the chimpanzee has a less striped face, and especially a much less ferocious one than the gorilla, whose jaws are comparable with those of the lion, and whose muscular strength is certainly greater than that of the king of the desert. The chimpanzee, like its congeners, dwells in great forests irrigated by creeks and rivers, and lives therein in large troops. Although it climbs with agility, it appears heavy and embarrassed on the ground. It can hardly walk then except by the aid of its hands, and by resting the back of its fingers upon the ground. Yet it appears that it also walks sometimes entirely upright, and it then crosses its hands over the nape of its neck; but when it is in a hurry or wishes to escape, it at once makes use of its hands, as we have indicated above, and makes a series of very droll jumps.

The chimpanzee lives upon fruits, nuts, and roots, and often robs the banana plants and fruit trees belonging to the negroes. The bands of these animals are always directed by the most vigorous male, says Brehm, and the vigilance of this leader is equaled only by his strength. It is asserted that a male chimpanzee, when he has reached his full development,

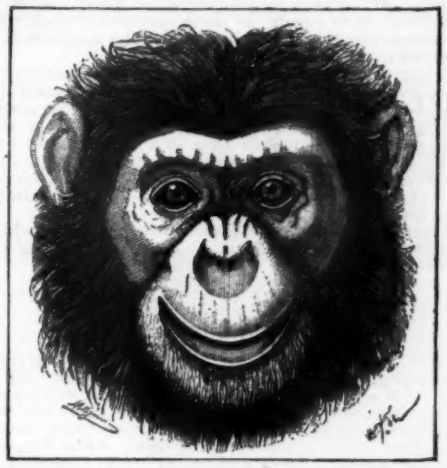


FIG. 2.—FACE OF AN ADULT CHIMPANZEE.

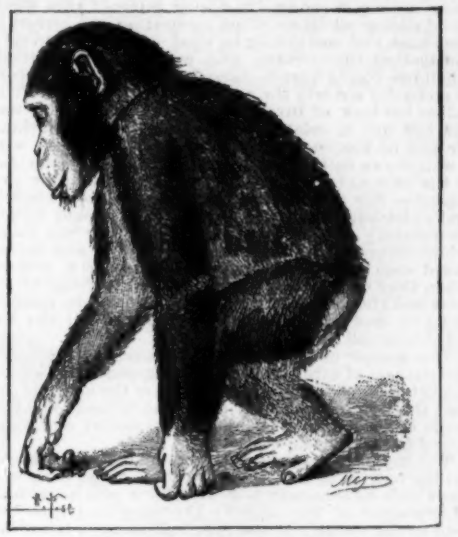


FIG. 3.—CHIMPANZEE WALKING.

breaks branches that two men would have trouble to bend. The negroes even go so far as to claim that one chimpanzee is strong enough to resist ten men. They add, it is true, that he never attacks man, and fights him only in self-defense. In case of danger, the chief of the band utters a cry that recalls that of a man in danger of death. The rest climb as quickly as possible to the top of the trees and utter sounds that somewhat resemble the barking of a dog. It is only in case that a hunter has killed a member of the band that the males rush upon him, and woe be to him then if the band is a large one!

Young chimpanzees have quite often been brought to Europe, but, unfortunately, they do not long withstand the climate. They generally succumb to phthisis.

The young give proof in captivity of very great intelligence. They readily learn to eat at a table, to make use of knives, forks, and spoons, to drink from a glass, and to wipe their lips with a napkin. They even become very quickly passionately fond of wine and liquors.

Buffon owned one which was extremely obedient, and which had been taught to set a table and wait upon it. It always stood erect, even in carrying the heaviest loads. Finally, it performed its duties very seriously and with the greatest punctuality. It offered its arm, too, to ladies who came to visit its master, and gravely promenaded with them.

The narratives of travelers who have had young chimpanzees in their possession are filled with statements of the same kind, but it appears that this mildness of nature, this facility with which they become tamed and, are trained, disappear with age. The character of the animals becomes willful, captivity irritates them, and they become dangerous and sometimes perfectly wild.—*La Nature.*

FIG. 1.—YOUNG CHIMPANZEES.

[FROM THE AMERICAN NATURALIST.]

THE CALIFORNIA GRAY WHALE.

(*Rhacheanectes glaucus*, Cope.)

By JOHN DEAN CATON.

I FIRST saw this interesting animal eighteen years ago, when running down the coast on the steamer Orizava. We then met them in considerable numbers when on their migration north. We were running but a few miles from shore, and generally observed them on the seaward side, but sometimes on the shore side. Sometimes they appeared quite close to the ship, and did not seem to be much alarmed by the presence of the steamer. I have since taken pains to inform myself of the habits and mode of capture of this great sea mammal, and think I may safely say that it is the most interesting of all the species of whale known to inhabit the great seas, perhaps because it is the best understood.

It does not inhabit the distant depths of the broad oceans, but its habitat is confined to the coast line of the Pacific, from Cape St. Lucas at the southern extremity of the peninsula of California to Behring Sea, and even into the Arctic Ocean, where it sports among the icebergs of the north with as much apparent pleasure as it rolls and tumbles among the great breakers in its southern range.

If other species of whales are as strictly migratory as this, we lack the evidence to prove it. If others wander about into different seas, and even go from ocean to ocean, they do not move with that regularity and system which constitutes what we call migration. With these this habit is as regular as the recurrence of the season, and is no doubt as universal as is that of most aquatic birds.

Wintering in the south, this migration to the north commences in the spring, first with the males, who, having no domestic duties or cares to detain them, leisurely proceed northward, and they are soon followed by the females with their young, so soon as the latter are large enough to undertake the long journey. Not that either sex move in a body and together, for they are scattered along the coast for even months, though they generally move in schools of greater or less numbers, among which both males and females may occur. Undoubtedly the former were laggards, while the latter were of the advance of the females.

Of all the families of whales, of this alone has it been possible to study the breeding habits with satisfactory results.

Along the coast, in the southern part of their range, numerous lagoons are found indenting the shores, near the mouths or outlets of which bars occur on which the surf breaks with great violence when the sea is rough, while the waters within are placid. These lagoons are the favorite breeding grounds of these whales, where they congregate in great numbers to bring forth their young, which occurs during the winter months, say from November till March. Although the fiercest fighters of all known whales, it has not been known that they are quarrelsome among themselves. So far as known, peace and quiet prevail among all the members crowded together in the upper ends of these water inclosures or lying-in hospitals. But few males have been observed to intrude themselves into the privacy of these retreats. The period of gestation is said to be about twelve months, and from analogy impregnation takes place within a very few days after the young are brought forth. Elliott's exhaustive observations show that such is the case with the fur seals, whose period of gestation is the same. Indeed, this must be so, when the period of gestation nearly corresponds with the year, else there could be no regularity in the time when the young are brought forth, but it would occur irregularly at all seasons of the year.

Another peculiarity of this whale is its fondness for sport or play. While this habit is solitary, it is distinctly manifest. Its favorite amusement is to sport in the breakers or the bars at the entrance to bays, lagoons, and rivers, and the greater the breakers, the more do they seem to enjoy them, for there they play and gambol about, increasing the foam by the use of their powerful flukes, sometimes fairly turning somersaults, while at others they will cease apparent exertion, allowing themselves to be rolled and tossed about, the passive sport of the angry waters.

Of all the known species of whales, this is the most cunning, courageous, and vicious. So terrible is it, that with the old implements of harpoon and lance, but few whalemen would court an encounter with it, and it early received the name of the devil fish. I have no account that it ever maliciously attacked an unoffending object, yet when it found itself pursued where escape was difficult, even before it was struck, it has

been known to turn upon pursuers and dash a boat to fragments with a single blow of its powerful flukes, and so has many a life been lost.

It was in the whale nurseries, in the retired lagoons, where the young were brought forth and nursed, for a considerable time after they were able to accompany their mothers for long distances out to sea, that the most terrible encounters occurred. The mother has a remarkable affection for her young, and will do and dare everything in its defense. Hence the whalemen were cautioned not to strike the calf while the mother was living. If she would not resent a severe wound to herself, while there was yet hope for escape that she might live to nurse and take care of her offspring, when once her darling was injured her rage knew no bounds, and there was no escape from her but to run the boat into shallow water or upon the beach. It is said that when in port the masters of whalers, in convivial mood, each recounting his adventures and escapes, those among them who had ever pursued this whale could silence all others when recounting the terrors of the chase, and would seek to rival each other in tales illustrating the ferocity and courage of the female when her young were in danger, and if the last in turn to come did not win the palm, it was his own fault or rather his lack of inventive genius. This is the way the last one to relate his experience won the drinks. He said he was once pursuing an old cow whale, with a well grown calf, and while he had cautioned the man in the bow not to touch the calf, the youngster presented so fair a mark that he could not hold himself, and so let him have it. Knowing what would follow, he instantly ordered all hands to pull for the shore, which fortunately was not far off. As they saw the enraged dam bearing down upon them like a tornado when they reached the shore, they tumbled out of the boat and thought they were safe. But no, she pursued them on land as well, and never stopped till she had treed them all!

The danger of the pursuit was much lessened, and the chances of capture of these dangerous animals was much increased, by the introduction of the harpoon gun and the bomb lance. By them the attack could be made at a safer distance, and the exploded bomb produced instant death.

The inshore habits of these whales made it possible for the natives to attack and capture them even with their rude implements, but as I have met no account of this south of Washington Territory, and rarely except in the vicinity of the Strait of Fuca, it is not improbable that much of the belligerent disposition of the brute may have left him by the time he has pursued his migratory journey so far, and especially may the temper of the female have been improved when the defense of her offspring was no longer demanded. Their mode of capture was simple, though ingenious, but could have only met with disaster in their southern breeding grounds. Their mode was to attack with a large number of canoes, each armed with several men and provided with a number of inflated bladders, or air-tight sacks made of skins; to each of these was attached a light strong cord, at the other end of which was an arrow. When a whale was sighted, the swiftly-paddled fleet pursued and embraced every opportunity for hours to shoot their arrows into him, always throwing overboard the proper air sack. Soon these began to tell by impeding his course through the water and preventing him from diving to as great a depth as formerly and obstructing his progress when fleeing from his pursuers. Thus in a longer or shorter time he might be literally covered with arrows, and so obstructed and loaded down, so to speak, with the air sacks, that he became quite helpless and finally succumbed to his swarming enemies, when by their united efforts he was towed to the shore and utilized in their way. This was only rendered possible by the peculiar inshore habits of this species of the whale.

For many years this whale was hunted from large whaling ships, which were anchored at convenient places near those locations where observation had shown the animal was most likely to be found, and from the ships whale boats were sent out to hunt for the game, and when captured they were towed to the ship and treated in the ordinary way. But this was an expensive mode of maintaining a whaling station, and as the objects of pursuit became scarce—notwithstanding the improved mode of capture by the use of the harpoon gun and bomb lance—the pursuit became unprofitable, when Yankee ingenuity proved equal to the emergency, and shore whaling stations were thought of. These are built upon the shore in sheltered places, but commanding an extensive seaward view.

Convenient structures are erected and equipped with all necessary implements and apparatus, with boats and arms for the capture of the whale, and everything on shore for treating the captive when brought to the shore. Near the station was a high lookout upon which a watchman was stationed with a well-understood system of signals, by means of which he could telegraph the boats when far out to sea. Here the men built comfortable cabins where they lived with their families, and later, as the whales became scarcer, they could pursue other avocations when their time could not be employed in the pursuit of their prey, which intervals increased as the whales became less and less abundant, till now many of these shore stations have been entirely abandoned. Here, in Monterey, the first whaling station was established on shore in 1851, and later another was established, both of which did a successful business for years, but within the last few years they have been entirely abandoned. Some of the buildings still remain, but they are fast going to decay, and the old whale boats may now be seen leaning up against the sheds, useless and abandoned. So at Carmal mission, a few miles across the peninsula; the absence of the game has compelled its desertion, and this is now true of most of the many whaling stations along this coast which once flourished. The station near the mouth of the bay of San Diego, I believe, is still kept up; at least when I passed it three years ago I saw two whales were on the ways.

Altogether we may well fear that this interesting species of this great family may before many years become extinct, as did the sea cow (unless governmental powers shall interpose to save them), which existed in incredible numbers about Behring Island when the great navigator was cast upon it, and where he found his grave in 1741.

The California whale may make a bolder and harder struggle for existence than did the rhytina, but it is rapidly going to utter extinction. While other species of the whale family have greatly diminished in numbers in all waters, still their habits protect them from final destruction. They have a wider range, and cannot be slaughtered on any exclusive breeding grounds. Here their nurseries are limited to particularly favored places which are known and accessible to all who choose to murder them, and it is a little remarkable that the State of California has not, long since, by stringent laws protected them, at least in the nurseries within her borders. If their capture were confined to the open waters of the ocean and to a reasonable distance from the mouth of the lagoons in which they breed, we might well hope to see them multiply rather than fade away to final extinction. Certain interests encouraged the extinction of the vast herds of buffalo which once roamed over the plains and even the forests of our country, that the ranchmen might have better pasturage for their stock, but no interest can be promoted by the destruction of this whale, while great interests would be subserved by its protection and increase. Other animals are protected which are of no practical value except as mere spectacles, while their existence involves a positive loss by the destruction of vast numbers of food fishes.

I might have stated before that the California whale, though not the largest of the family, is of a good size, the largest measuring forty to fifty feet in length, though the average is considerably less than this. They are fairly robust in form and well covered with fat. They furnish no whalebone, but they produce from twenty to seventy barrels of oil, which, though not of the best quality, commands a good price in the market.

Solitary individuals of several other species of whales are frequently taken at the shore stations along this coast.

FLOWERING TREES AND SHRUBS.

By W. GOLDRING.

Fabiana imbricata.—A pretty and interesting shrub belonging to the potato family (Solanaceæ), but so much resembling a heath that it might well be mistaken for one. It is a slender-growing shrub with evergreen leaves, and in early summer every shoot is wreathed with a profusion of small white trumpet-shaped flowers. It is a native of Chili; therefore not perfectly hardy as a bush except in the southern counties, but is very suitable for growing against walls in cold districts.

Forsythia.—Of the two species of Forsythia, one of them is the most charming hardy deciduous shrub we possess. This is F. suspensa, with elegant long shoots, half climbing, half trailing. In early spring, usually in April, this shrub is hung profusely with strings of golden, bell-like flowers adorning every twig, and lasting in perfection for a fortnight or longer. It is thoroughly hardy, grows quickly, and is indifferent to soil if not excessively stiff or light. If planted in an open spot and sheltered from strong winds, it makes a delightful spreading bush, and sends out its long, graceful shoots on all sides. It also makes an excellent wall covering, as its shoots, when they reach a few feet high, fall over in a most elegant way. It is also suitable for planting in rock gardens, so as to trail over bold rocks. It is an indispensable shrub in every garden, large or small, and, if space permits, it should be planted in lawn groups of five or six plants together. The names of F. fortunei, Sieboldi, apply to forms of F. suspensa (see illustration) not differing materially from the original. F. viridissima (here illustrated), though less graceful in growth than F. suspensa, is, nevertheless, a desirable shrub. It is of erect growth, with stout, stiff shoots, which in early spring are covered with yellow blossoms, bell-shaped, and about as large as those of F. suspensa. It generally grows from

GARRYA ELLIPTICA—FRUIT-BEARING CATKIN.

FORSYTHIA SUSPENSA.

3 feet to 5 feet high, though in crowded shrubberies it sometimes shoots up as high as 8 feet or 10 feet. The name viridissima has reference to the green bark of the shoots. It is a native of Japan and perfectly hardy, while suspensa is a Chinese plant.

Fothergilla alnifolia.—A North American shrub of dwarf growth and deciduous. It is desirable on account of its flowering so early in the spring. It produces feathery tufts of fragrant white flowers before the leaves, which resemble those of the common alder. Suitable for a moist peat border or low parts of the rock garden.

Fremontia californica.—This (an illustration of which is given) is a handsome deciduous Californian shrub. It is scarcely hardy enough for the open air

FABIANA IMBRICATA.

without protection, but there are few more beautiful wall shrubs. It has large bowl-shaped flowers, 2 inches across, of a bright yellow color, while the leaves are deep green and lobed. In favorable spots it reaches 10 feet or 12 feet in height, and flowers in early summer. It succeeds best against a north, west, or east wall, a southern exposure being too hot and dry for it as a rule.

Garrya elliptica.—A well known evergreen from California, beautiful also as a winter flowering shrub. In mild winters it begins to flower as early as December, producing amid the handsome deep green leaves a profusion of its gracefully drooping pale green catkins in tufts. Flowering twigs of the Garrya cut and placed in vases in rooms endure a long time, and are very acceptable in winter. Though generally seen as a wall shrub, this Garrya is thoroughly hardy and makes a dense bush from 5 feet to 8 feet high, according to the situation. In cold parts it is advisable to give it the benefit of shelter, but in the south and west it does not require this. If planted in a shrubbery, it should always be placed near the path and not allowed to become crowded, as then its beauty can be enjoyed. There are various other kinds of Garrya in cultivation,

but G. elliptica is the only one worth considering here. There are male and female forms of it, the most elegant being the pollen-bearing or male plant.

Genista.—In this numerous genus there are several beautiful garden shrubs, which are, however, more suitable for the rock garden than the shrubbery. Among these are G. tinctoria, anglica, anxantica, sagittalis, and pilosa, which for the most part are dwarf or prostrate shrubs, bearing yellow flowers. They are suitable for spots in the rock garden where they can be fully exposed and their shoots can ramble among and over bowlders. In such positions their beauty is fully seen. The taller growing Genistas are few, but these are valuable. G. elata is one of the most noteworthy, and is not much known. It is a tall-growing, spreading bush, often 8 feet or 10 feet high. It is suitable for light soils, and in late summer is covered with a profusion of small pea-shaped flowers, which make the bushes glow with yellow, and thrives well as undergrowth to large trees if not too densely shaded, and is altogether a first-rate flowering shrub. The Etna broom (G. ætnensis) is a slender, tall-growing shrub, from 3 feet to 12 feet high, and of most elegant growth. In August it is a mass of yellow bloom, which is then the more appreciated, as few other shrubs flower at that season. There are other Genistas to be seen in botanical collections, among them G. ephedroides and monosperma, but those described are the best for general culture. Being mostly natives of Europe they are quite hardy and suitable for almost all kinds of soil, though they prefer a warm, light one.

Gordonia (*Loblolly Bay*).—The two Gordonias in cultivation, G. pubescens and G. lasianthus, are very beautiful shrubs, but are far too rare in English gardens, owing probably to the difficulties attending their propagation. The genus is allied to the camellia, and the two species named are very old garden plants,

FORSYTHIA VIRIDISSIMA.

introduced during the last century. G. pubescens is a shrub of camellia-like growth, 6 feet high, bearing in late summer beautiful flowers 3 in. across, pure white, with a center tuft of yellow stamens. G. lasianthus is taller and more robust in growth and has larger and more fragrant flowers than G. pubescens. Both are natives of the swamps near the coast of the Southern States of North America, therefore are not among the hardiest of shrubs, but in our southern and coast counties they need no protection. Both species are obtainable in the best nurseries.

Grevillea.—These Australian shrubs are generally grown in the greenhouse, but there are a few quite hardy enough for wall culture. Among these are G. sulphurea, the hardiest species in cultivation, and which flourishes freely against walls about London. Its flowers are pale yellow, of curious shape, as in all Grevilleas produced at no particular season, but continuously throughout the summer. G. rosmarinifolia is another hardy kind, having rosemary-like leaves and red flowers in clusters. The Grevilleas, like other half-hardy shrubs, like a warm wall in a sheltered situation.

Grabowskia boerhaaviæfolia.—An ugly name for a not very beautiful shrub. It belongs to the potato family, and is hardy enough for the open air, though a native of Peru. The flowers are dull pale blue and not showy. It may be well to know the name, so as to avoid the plant.—*The Garden.*

ALIMENTARY AQUATIC PLANTS.

By P. L. SIMMONDS, F.L.S.

IN the last number of the "Bulletin of the Paris Society of Acclimatization," 5th August, an article appears on this subject, which merits attention from the novelty of the information furnished, and while drawing one or two items therefrom, I may add some supplementary detail which will be interesting. It will come as a surprise to many that in Asia and in parts of North America thousands of people feed on the farinaceous seeds of certain water plants. I do not here allude to the enormous crops of cultivated rice in Asia, nor to the wild rice (*Zizania aquatica*) or *fluitans* of America, but to the various water lilies, the seeds of which are such a large source of subsistence to many. First we have the species of *Trapa*, known in India under the name of "Singhara." The plant is also cultivated on a large scale in the lakes and rivers of Southern China.

Fortune thus describes it: "Being detained for some time at Shanghai, I resolved to penetrate, if it were possible, into the district of Kwey-chow-foo. In ascending the river in a southwesterly direction, I soon arrived, after passing Kea-Hing-Fo, a city of 230,000 inhabitants, at an immense pool, which I suppose communicates with the celebrated Lake Tai-ko. The water, not deep, was covered with *Trapa bicornis*, which the Chinese call ling, the bizarre fruit of which, resembling a bullock's head with two horns, is highly esteemed in China. I noticed three very distinct varieties, one of which bore fruit of a fine red color. Women and children in great numbers were paddling about in small boats of a circular form, like washing tubs, collecting the seeds. Nothing could be more curious than these singular boats, large enough to contain the person and the product collected, and pushed about among the plants without injuring them. The sight of this immense number of individuals floating about in their little tubs in this swamp was to me most diverting."

Another voyager, M. Marchal de Luneville, states: "The *Trapa bicornis* forms the food of the people when the rice crop is insufficient. The collection reminds me of the grape harvest in Europe. The 'ling' is sown at the close of autumn, in those ponds where the water is shallow and clear, and in localities exposed to the south. The Chinese affirm that this culture absorbs the putrid emanations which rise to the surface of the stagnant waters. If the harvest is abundant the seeds are given to poultry, which fatten readily on them, and their flesh acquires an exquisite flavor. This water chestnut, as it is termed, is considered refreshing and agreeable food in summer. In its green state it is sold in the markets of Pekin as nuts are in Europe. Dried and reduced to flour, it makes a good gruel, and it may be mixed with flour for bread. Roasted or preserved in sugar or honey, it is a pleasant food. It is also excellent food for geese, ducks, and other birds of the poultry yard."

The species which is cultivated in Kashmir, according to Roxburgh and Sir J. D. Hooker, is believed to be *Trapa bispinosa*, although usually stated to be *T. natans* and *T. bicornis*. It is met with from Central and Southern Asia (where it is called *Singhara*) to Ceylon and Japan, and also reaches in the south of Africa to Zambesi. To this species probably belongs *T. cochinchinensis*, Lour., and *T. incisa*, Seib. *T. natans* is said to have furnished a large part of their food to the ancient Thracians, in the same manner as *T. bispinosa* does at the present day to the inhabitants of Kashmir and *T. bicornis* to the Chinese. It is mentioned by Dr. Royle that the former yielded as much as £12,000 a year of revenue to the government of Runjet Singh, the tax being levied upon from 96,000 to 128,000 ass loads from the great Lake of Ooller.

In Kashmir, after a severe famine, the governor of the district in which is situated the Woos Lake introduced the culture of the *Trapa* This lake, which measures at least 5,000 acres, is so filled with this

THE SLIPPERY ELM OF CALIFORNIA (FREMONTIA CALIFORNICA).

plant that navigation is impossible. The fruit is collected by entire boat loads, and the governor derives a large revenue from it. Many of these boats filled with seeds arrive daily at Srinagar.

The seeds of the *Trapa bispinosa* and *T. natans* contain a great quantity of fecula, and are eaten by the natives. In Gujerat they form an important article of food. During the Hooly festival a red dye is made from the fruit, mixed with a yellow dye from the flowers of the *Butea frondosa*. Colonel Sleeman has given the following interesting account of this plant in his "Travels in the Southwestern Provinces:" "Here, as in most other parts of India, the tanks get spoiled by the water chestnut (*Singhara*), which is everywhere as regularly planted and cultivated in fields under a large surface of water as wheat or barley is on the dry plains. It is cultivated by a class of men called Dheemurs, who are everywhere fishermen and palankin bearers, and they keep boats for the planting, weeding, and gathering of the *Singhara*. The holdings or tenements of each cultivator are marked out carefully on the surface of the water by long bamboos stuck up in it, and they pay so much the acre for the portion they till. The long straws of the plants reach up to the surface of the water, upon which float their green leaves, and their pure white flowers expand beautifully among them in the latter part of the afternoon. The nut grows under the water after the flowers decay, and is of a triangular shape, and covered with a tough brown

integument adhering strongly to the kernel, which is white, esculent, and of a fine cartilaginous texture. The people are very fond of these nuts, and they are carried often on bullocks' backs two or three hundred miles to market. They ripen in the latter end of the rains in September, and are eatable till the end of November. The rent paid for an ordinary tank by the cultivator is about 100 rupees (£10) a year. I have known 200 rupees to be paid for a very large one, and even 300, or £30 a year. But the mud increases so rapidly from the cultivation that it soon destroys all reservoirs in which it is permitted; and where it is thought desirable to keep up the tank for the sake of the water, it should be carefully prohibited."

In Kashmir, miles of the lakes and marshes are covered with it, and the fruit forms the staple food for some months in the year to a large number of people. It abounds in starch, resembles a chestnut in flavor, and is eaten either raw or cooked. Flour is made of it, which is eaten by Hindoos on fast days, also made into sweetmeats.

A variety of *T. natans*, to which the name of *T. verbunensis* has been given, is cultivated in the lakes of Majena and Varesa in Italy, especially in the Bay of Angera, Lake Majena, where the bottom is visible. With the seeds, chaplets of beads are made, and sold in Rome, Varesa, and other places. Necklaces made of the nuts are also sold at Benares, and considered very sacred.

Capt. J. P. Pogson, of Simla, advocated, some years since, in the *Journal of Applied Science*, the more extended culture and utilization of this plant. "With the example of Kashmir before us, it seems very singular that the vaunted tanks, large lakes, and inland fresh water sea of the Madras Presidency, as well as the immense 'jheels' of the North-Western Provinces and Oudh, are not, as a rule, turned to most profitable account by being placed under *Singhara* cultivation. The dried nuts will, I believe, keep for many years, and as arrowroot, or rather *Singhara* starch, will always sell in England, either as food or for manufacturing purposes. All old *Singhara* stock could be so converted and sold.

"Like the grain of wheat, the kernel of the *Singhara* nut is capable of sustaining life for an indefinite period, and is palatable, whether seasoned with salt and pepper, or made into porridge with sugar, ghoor, or jaggery. If the kernels are broken into small bits, they may then be ground into meal in a hand mill, and the produce kneaded up into dough, and made into small 'chuppaties,' or cakes. If the kernels be soaked overnight in cold water, next morning a simple boiling converts them into food—steaming would do as well, perhaps better; but I have as yet only tried the soaked kernels in the boiled state. I have, years ago, eaten 'hulwa' made of *Singhara* meal, and it was more palatable than that made from fine wheat flour.

"The Madras Presidency possesses some magnificent ancient waterworks. The Viranum tank, with its area of 35 square miles and its embankment of 12 miles; Cauverypank tank, with its embankment of 4 miles, riveted along its entire length with stone; the Chembrumbankum tank, looking like a picturesque inland sea, are of unknown antiquity. The first of these artificial lakes equals 22,400 acres of surface, and the third being compared to an inland sea, may be ten times that size. It is an officially authenticated fact that in Kashmir 30,000 human beings are, for five months out of the year, fed and sustained on the Singhara nut, and if the picturesque inland sea under notice is at all deserving the name, its bed and water surface might be most profitably utilized by being put under Singhara cultivation. The tank of 35 square miles might become a first-class nursery for supplying seed nuts to Madras.

"The productiveness of the water nut, per acre, is at present unknown; but supposing the yield to be four quarters (480 lb. each) of nut kernels per acre, then the 22,400 acres would give 43,800,000 pounds of food, and at 60 lb. per adult per month, the above quantity would suffice to feed 716,800 human beings for one month, and 143,360 adults for five months. The cost of this large and perennial supply of food would be a mere trifle. There are 4,000 square yards in one acre, and allowing one seed nut to each yard, the price of the nuts and the railway freight may be easily calculated. The first year's harvest would more than cover all cost, and thereafter in perpetuity a harvest would result which would only have to bear the cost of watch, ward, and collection. The entire crop being state property, a very considerable revenue would be derived from the sale of the nuts, even if the kernels were sold at half the price of rice or other grain.

"In good seasons, the agricultural population would freely use this cheap and nourishing food, and sell and export rice crops, etc., and in bad seasons of famine the growing crop of water nuts would be a stand-by. In fact, their presence would go far to prevent the artificial production of local famine.

"The nuts, once sown, resow themselves, and in this way the square yard might soon be growing nine water plants or more. The inland sea, when covered with these nuts, would be a source of wealth to the state, and the public would be greatly benefited. As the annual extension of the cultivation, spontaneous and artificial, is a very simple affair, the Madras government would, in a few years, find themselves to be the proprietors of very valuable Singhara plantations."

Captain Pogson, writing from Simla, states: "The Singhara nut of India and Europe bears fruit annually from the old roots, being a perennial aquatic plant. If sown in water two feet deep, the nuts may be gathered by going in, wading about, and collecting them in a floating vessel, say a five-gallon cask. If in deeper water, any sort of raft, float, or canoe will have to be used, and the nuts picked off. In this country (India), several pickings take place during the season, and the last batch of nuts, *i. e.*, those that are of a large size and the kernel hard, are boiled and so eaten. Others are shelled and dried and made into meal, while others again are buried whole, to be used next season for seed. For example, the pool or depression which has borne a crop of nuts may dry up during the hot weather; when the rains commence the locality will become a pool *de novo*, and the stock of seed nuts are then dug up and sown twelve inches apart in the shallow water, putting each nut about two inches deep in the submerged soil, and this process is repeated daily as the waters rise. In due course the nuts will germinate, and yield that year's harvest. Of course, if the water did not dry up the old roots would remain alive, and in season send up a fresh crop of stems, which would in due course bear fruit. Hence, if required to become a perennial crop, the nuts must be sown in the beds of shallow fresh water pools which never dry up."

The Pythagorean bean, the *Nelumbo nuciferum*, Gaertnar; *Nelumbo speciosum*, Willdenow; and another species (*N. luteum*) have seeds of a particularly pleasant taste. The capsular fruit contains from twenty to forty of these seeds. The seed vessel is of a peculiarly beautiful form. The top, becoming detached when ripe, discloses a chamber with five partitions. The seeds were much used as food in ancient Egypt, but seem to be neglected now. These retain their vitality for several years. The tuberous roots of both species resemble the sweet potato (*Batatas edulis*), and are starchy. The root stocks when boiled are farinaceous and agreeable, and employed as food by the Osage and other Western Indians.

The seed vessel or receptacle of the fruit of the lotus (*N. speciosum*) is large, in the shape of an inverted cone, and has the nuts placed loose in apertures, or cells, on the surface; it has not inaptly been compared to the rose of a watering pot. The whole, in process of time, separates from the stalk, and, laden with ripe oval nuts, floats down the water. The nuts vegetating, it becomes a cornucopia of young sprouting plants, which at length break loose from their confinement, and take root in the mud. The lotus flower is highly venerated by the Hindoos, and is given as a valuable offering to the gods. The seeds, in India, are eaten raw when green, and roasted or boiled when ripe and hard. The root, which is two or three feet long, is eaten, boiled, as a vegetable.

The Klamath Indians of Northwest America live chiefly on the "tookow," or seeds of the yellow water lily (*Nuphar lutea*), which is the staple of their winter food. The capsules are broken, and the seeds separated from their husks.—*Jour. Soc. of Arts.*

THE REJUVENESCENCE OF OLD TREES.

THE fact that old and apparently decrepit deciduous trees can be rejuvenated by judicious pruning is not well understood in this country, where old trees which might perhaps be made to live a century or two are often allowed to perish unnecessarily. The death of a tree can generally be traced to a gradual failing of vigor, due to insufficient nourishment, or to internal decay, the result generally of neglect. The first indication of danger usually appears at the top, and when the upper branches of a tree begin to die, it is a sure indication that unless radical measures are taken to check the trouble, it can only live a comparatively short time. Vigor can be restored to a tree in this condition by shortening all its branches by one-third or one-half of their entire length. The only care needed in this operation is to cut back each main branch to a healthy lateral branch, which will serve to attract and elaborate, by means of its leaves, a sufficient flow of sap to insure the growth of the branch. This is essential in good pruning, and, if neglected, the end of the branch will die back to the first lateral branch or bud below the cut, leaving a point of danger to the tree. Care, too, must be taken to shorten the branches in such a way that the lowest will be the longest, that the greatest possible leaf surface may be exposed to the light. Fig. 1 will serve to show how an ancient oak should

FIG. 1

be pruned for the purpose of increasing its vigor.* The vigor of a tree depends upon the power of its leaves to elaborate plant food. The larger the leaf surface exposed to the light, the greater will be the vigor of the tree. The object of pruning, therefore, is to increase leaf surface. If half of a branch of a decrepit tree, bearing small and scattered leaves, is cut away, the leaves which will grow upon the half which is left will be so large that their total area will often be more than double the total area of the leaves upon the whole branch before it was cut. The truth of this statement can be easily verified by cutting down to the ground in the spring a feeble seedling oak, or indeed any young seedling tree, when a tall, vigorous shoot, twice the height and diameter, perhaps, of the slender stem it replaces, will appear at the end of a few months, and, although this shoot will only produce a few leaves, its greater vigor is due to the fact that a larger leaf surface is presented to the light by these few large leaves than by the more numerous smaller leaves of the original plant. The vigor, too, of a tree can be increased after it has been pruned by a good top dressing of well rotted manure or of fresh soil applied over its roots; and trees growing on banks can often be benefited by deepening the soil on the lower side. A large body of plant food can thus be supplied without burying any part of the trunk and without injury to the tree.

The internal decay by which so many old trees perish, through inability to resist the influence of storms, is caused by dead branches allowed to remain upon the tree or from the stumps of branches left in pruning. It is an almost invariable custom in this country, when a branch is cut from the stem of a tree, to leave a stump a few inches long, as shown in Fig. 2. The end of this branch, as it has no lateral shoot to insure a flow of sap, is not healed over with a new formation of wood

FIG. 2.

and bark, and soon dies. Decay thus begins, as appears in Fig. 3, and this decay gradually extends into the interior of the trunk, as shown in Fig. 4, ruining the tree for any useful purpose, and so weakening the supporting power of the stem that a severe gale will prostrate it. This decay can be prevented by cutting off dead branches as fast as they appear, and by cutting living branches, when it is necessary for any reason to remove them, close to the trunk or close to a lateral branch. The secret of good pruning lies in cutting close, so that the wound may heal by the formation of a new growth over the cut surface. No matter how large it may be necessary to make the wound, no branch stump, large or small, should be left in pruning. A coating of coal tar applied to the wound as soon as made will serve to protect it from moisture, and will not interfere with the formation of a new layer of wood.

Pruning, so far as the trees are concerned, can be done at any time, except in very early spring, when they are gorged with sap and "bleed" more freely

FIG. 3.

than at other seasons of the year. The autumn, however, is found to be the best time for such work. There is more leisure now than earlier in the season, while the coating of ice which often, in this climate, covers the branches of trees in winter makes it difficult and dangerous to work among them.

Three men at least are needed to prune a large tree properly, and to manage the long, heavy ladders which this operation makes necessary. One man stands at a little distance from the tree and directs where the cuts shall be made; the second man uses the saw, which must be attached often to a long handle; while the third holds one end of a rope fastened to a belt on the man in the tree, and passed over a branch above his head as a precaution against a fall. Nearly all our forest trees bear severe pruning of this sort, and improve under it. Decrepit red, black, white and swamp oaks, black birches, beeches, hickories, and elms have been pruned in this way in the Arnold Arboretum, where many of the trees in the natural woods were perishing from pasturage and neglect. They were covered with dead branches, the foliage upon them was thin and poor, and their dying tops showed that

FIG. 4.

they had but a short time to live. It was important to preserve many of these old trees until a new growth of self-sown seedlings could be brought on to replace them and a covering to the forest floor grown. A portion of these old trees are pruned each year, and those which were operated upon first, or six or seven years ago, show, in their dense, dark colored foliage, compact habit and vigorous growth, how pruning can, without fresh soil and without the aid of manure, put new life into feeble and dying trees.

It often happens that when trees have grown together thickly, as in a forest, they are destitute of lower branches. When such trees are thinned, as often happens in the improvement of grounds, single specimens are left with long, straight stems, and without foliage except at the very top. Such trees, from the point of view of ornamental gardening, are ugly objects, and are, moreover, liable to blow down in the first gale.

But there is no deciduous tree, however tall and unsightly it may be, which cannot be gradually converted into a handsome, branching specimen, by the aid of a saw and a pot of coal tar.—*Garden and Forest.*

* We are indebted to the trustees of the Massachusetts Society for Promoting Agriculture for permission to reproduce these figures, which are extracted from Monsieur A. Des Car's work upon tree pruning, of which an English edition was published in 1881, by the Massachusetts Society, under the title of "A Treatise on Pruning Forest and Ornamental Trees," a work in which the whole theory of pruning is clearly explained and illustrated.

MASTIC.

Pistacia lentiscus, L.

By JOHN R. JACKSON, Curator of the Museum, Kew.

THE knowledge and use of this resin has descended to us from very remote times. Hippocrates, writing some four centuries before Christ, speaks of the use made of it for medicinal purposes. Theophrastus, a little later, describes the tree under the name of *Schinos*, and says that the resin exudes in drops or tears from incisions made in the bark, and soon concretes by the heat of the sun. Dioscorides also mentions the tree under the name of *Schinos dendron*, and the resin under that of *Retina schinine*, or mastiche.

The lentisk tree, from which mastic is obtained, is found in many parts of Southern Europe, Northern Africa, and Western Asia, but it does not yield the resin in equal abundance in all these countries, for Desfontaines tells us that in Barbary very little or no resin can be obtained from incisions, and the same may be said of Italy, Portugal, and other Southwest European countries. The principal supply of mastic, both in ancient and modern times, has always been obtained from the Greek island of Chios, or Scio, as it is now called, where the tree is carefully cultivated on a large scale. Some, however, is produced in Asia Minor, but the Scio kind is most in repute. The best account of the collection of mastic in Scio is that given by Tournefort, who visited the island in 1701, and very little alteration has taken place since his time, except in the manner in which the Turks obtain their revenue from it. He first tells us that the villages in the island are divided into three classes, those of Del Campo, those of Apanomeria, and those where they plant lentisk trees. The latter are 21 in number, viz.: Calimatia, Tholopotami, Merminghi, Dhidhimo, Oxodidhima, Paita, Cataracti, Kini, Nenita (where is the famous Chapel of St. Michael), Vounos, Flacia, Patrica, Calamtia, Armoghia (where they make stone pots), Pirghi, Apolychni, Elimpi, Elata, Vesta, Mesta (in the renowned Arvisian field). "All the lentisk trees belong to the grand signior, and they can't be sold but under condition that the purchaser pay the same quantity of mastic to the emperor; generally the land is sold and the trees reserved." He then gives a full description of the tree itself, and expresses his belief that if incisions were made in the lentisk trees in Candia and the islands of the Archipelago, and even in those of Provence, some of them would yield as much mastic as those of Scio. "Even in Scio," he says, "there are many trees that yield hardly anything. Such stocks, therefore, as plentifully shed their nutritious juice by incisions must be preserved and propagated." With respect to the cultivation of the tree, he merely informs us that "they sometimes prime 'em by moonlight in October." Regarding the collection of the resin, he says: "They begin to make incisions in these trees in Scio the first of August, cutting the bark crossways with huge knives, without touching the young branches; next day the nutritious juice distills in small tears, which by little and little form the mastic grains; they harden on the ground, and are carefully swept up from under the trees. The height of the crop is about the middle of August, if it be dry, serene weather; but if it be rainy, the tears are all lost. Likewise, toward the end of September, the same incisions furnish mastic, but in lesser quantities; they lift it to clear it of dust, which sticks so fast to the faces of those employed that they are forced to use oil to wash it off. There sometimes comes an aga from Constantinople to receive the mastic due to the grand signior, or else they appoint the custom house officers of Scio to receive it, who go to three or four of the chief towns before named, and give notice to the inhabitants of the rest to bring in their contingent. All these villages together owe 286 chests of mastic, weighing 100,025 okes. The cadi of Scio takes three chests, each weighing 80 okes; one chest goes to him that keeps the accounts; the officer at the custom house that weighs the mastic takes a handful out of each man's parcel. The garbler or sifter likewise has as much for his pains. If any person is caught carrying mastic to such towns as do not plant the tree, they are sentenced to the galleys, and stripped of all they are worth. Such of the peasants as gather not enough mastic to pay their quota buy or borrow of their neighbors, and those who have more than enough keep it for the next year, or sell it privately. Sometimes they compound with the custom house officer, who takes it at one piaster the oke, and sells it for two or two and a half. The planters of the lentisks pay but half the capitation, and wear the white sash round their turbans as well as the Turks."

The system here described by Tournefort remained in force with little or no modification until the year 1850, when a large number of the lentisk trees were destroyed by severe cold. This mishap induced the Turkish government to relinquish their claim to the exclusive collection of the mastic, and they made over the right to the twenty-one villages where the tree is cultivated, upon the condition that the inhabitants should pay the sum of 400,000 piasters per annum. The production of the resin is still confined to the villages in the southern part of the island, as mentioned by Tournefort, the northern part, and also the neighboring islands, being unfitted for its production.

Campbell, in his report on the trade of Scio between 1854 and 1858, states that before the cold of 1850 the lentisk trees produced from 45,000 to 50,000 okes; but, owing to the number of trees killed by the frost, the amount was greatly reduced in the subsequent years. The quantity and value of the mastic exported from Scio in each of the years from 1854 to 1858 is stated by Campbell as follows:

	lb.	£	s.	d.	
1854	26,200	value 13,200 at	10	8	per lb.
1855	33,200	" 16,200 "	9	9	" "
1856	40,500	" 20,727 "	10	3	" "
1857	45,125	" 20,275 "	9	0	" "
1858	43,750	" 22,325 "	10	2	" "

In 1871 Scio exported 28,000 lb. picked and 42,000 lb. common mastic.

The principal portion goes to Constantinople, Smyrna, and other Turkish towns in the Levant, where it is largely consumed as a masticatory. The custom of chewing mastic has prevailed in the East from the most ancient times, and in some of the large cities is almost universally practiced by both sexes, particularly in the cafes, where the attendants present it to their customers. Tournefort says: "The sultanas consume the greater part of the mastic assigned for the seraglio; they chew it by way of amusement, and to give an agreeable smell to their breath, especially in a morning fasting; they also put some grains of mastic in perfuming pots, and in their bread before it goes to the oven. Mastic is likewise beneficially used in distempers of the stomach, and the *Primæ viæ*, to stop bleeding and fortify the gums."

The English word *mastication*, applied to the art of chewing, is derived through the Latin *masticatio*, from *mastiche*, the ancient Greek name of the resin, evidently in consequence of this ancient custom of chewing mastic. The island of Scio, or Chios, as it was formerly called, also is supposed to have obtained its name from *Schinos*, the Greek name for the lentisk tree.

The yield of the resin is comparatively small; a fine tree may give only a total of from 8 to 10 lb., and a shower of rain during the gathering time produces disastrous results. Four qualities of mastic are known, namely, cake, which consists of the large pieces, and which is considered the best, and is sold chiefly for use in the seraglios; large tears, small tears, and the most inferior quality, which is mixed with fragments of leaves and other refuse, and is used in the preparation of the liqueur known as raki, or mastic brandy.

Mastic possesses stimulant and diuretic properties similar to common turpentine. It is now but little used in medicine in this country, although at one time it was a favorite remedy. With us its chief use is in the preparation of varnishes, for which purpose it is dissolved in oil of turpentine or alcohol. It is also used by dentists for filling up the cavities of carious teeth. Mastic is but little adulterated, though it is sometimes mixed with sandarac, olibanum, and similar resins. In the Indian bazars a resin very similar to mastic is sold produced by *Pistacia cabulica* and *P. khinjuk*, found all over Scinde, Beloochistan, and Afghanistan, both of which species, however, have quite recently been placed under *P. terebinthus*, L. The better qualities of the resins from these trees much resemble true mastic, and sometimes find their way to the European markets under the names of East Indian or Bombay mastic.

HOW TO MAKE A TENNIS LAWN.

MINUTE and explicit directions for making a tennis lawn cannot well be given that will apply to every case. The question of expense, to begin with, is often the most important element of the problem; but even if this be a minor consideration, there will, usually, be other limitations, to meet which good judgment and experience will be required. The climate is the main difficulty that has to be contended with in this country, and the mistake most commonly made is insufficient and superficial preparation of the soil before seeding or sodding. This error not only greatly increases the expense of maintenance, but prevents the attainment of the best results even with the best of care taking. With a soil of proper texture and sufficiently fertile, it is only required to follow the directions which have been given in former numbers of this journal for making a good lawn, taking special care to have it firm and level. It often happens, however, that a tennis court is wanted where the soil conditions are unfavorable, and then the proper preparation of the soil may be a difficult and expensive task. This preparation of the soil involves two distinct qualities—its mechanical condition and its chemical composition. The soil should be porous enough to absorb sufficient rain water, and to afford ready passage for roots, and yet compact enough to prevent the water absorbed from quickly draining away and evaporating too rapidly; and it should, also, be so firm as not to be stirred up by the grinding action of feet upon it, which would otherwise break the roots and crowns of the grass. In short, the soil should be porous, and yet have a "binding" quality. Sand is porous, but will not bind. Clay will bind, but is not sufficiently porous. A proper mixture of the two will produce the mechanical quality desired.

It is safe to assume that most soils need enriching. For this purpose there is nothing better than rotted barn yard manure. But it is often more economical to add a mixture of properly prepared peat, muck, or leaf mould and commercial lawn fertilizer, than to use barn yard manure exclusively. The question as to how much manure should be added to a soil is so much one of expense and judgment that no definite rule can well be given. An ordinary farm field, in fair condition, may have manure, at the rate of twenty cart loads to the acre, plowed in when it is laid down to grass, and a top dressing of a like amount every three years or so. Ornamental grounds of large extent, in which a better result is desired, and yet in which a careful economy must be observed, may have at least twice that amount plowed in at the start, and an annual top dressing of half as much to the acre may be applied. A tennis lawn or any other ground upon which turf is to be maintained, that is subject to much wear, may, however, well have more.

The soil of a tennis lawn should be deep, that the roots of the grass may easily descend to permanent ground moisture, just how deep, up to three or four feet, being a question of expense. The top soil, or mould, and subsoil of good quality, taken together, should extend to that depth, if practicable, in order to retain sufficient moisture to last over droughts. It is more economical in the long run to so prepare the soil in the beginning as to store up natural moisture than it is to supply it artificially upon the surface when needed.

In some instances, however, there will be, at times, too much natural moisture in the soil, and underdrainage is the remedy for such cases. In the case of stiff, clayey soil, another and very important advantage in under-drainage is to make it more porous and pervious to roots. Drainage is best effected by laying land tiles at least two inches in diameter at a depth of three or four feet and thirty or forty feet apart, care being taken to give them a sufficient pitch and a proper outlet.

For deep preparation of the soil, trenching should be resorted to. This process consists in throwing back the top soil on a strip from three to ten feet wide, so as to expose the subsoil, which is then dug up and turned over, or thrown back if it is desired to work more deeply. The lumps are pulverized, clay or muck mixed in, if the original soil is too sandy, or sand and peat, if too clayey, and stones, stumps, and roots of large size thrown aside, and all necessary grading and leveling done. Then the topsoil of the next strip is thrown upon the strip of subsoil thus prepared, great care being taken to sift out all the roots of weeds and coarse grasses. And so on.

It not infrequently happens in New England and other parts of the country that have been subjected to glacial action and deposit, that both the topsoil and subsoil consist of dry, coarse sand and gravel, upon which it is almost impossible to maintain good turf, after the ordinary preparation, without an extraordinary amount of manure and almost constant watering during dry weather. In such a case, it is an economy to throw back the soil strip by strip, as for trenching, and to place at a depth of three or four feet below the surface a layer of clay about six inches thick, which may be put in dry, if broken to a fine powder, or, which is usually easier, it may be wet and "puddled"—that is, worked into a comparatively homogeneous mass of mud. In either case it forms an impervious bottom to the lawn, thus preventing the rain which falls or the water which is applied from settling down too deep for the roots of the grass to reach it. The sides should, of course, be left sufficiently porous to allow excessive moisture to drain off.

Another case would be where the soil was almost pure clay, and where no muck or sand or finely divided mineral matter could be obtained without excessive cost. In such a case, the ground having been thoroughly underdrained, the usual way is to mix in almost any sort of vegetable fiber, such as leaves, half-decayed twigs, leaf mould from the woods, sods, weeds, the tops and refuse of vegetables, and the like.

After the subsoil has been thoroughly prepared, the topsoil is manured and deeply harrowed several times. The ground should then be leveled, rolled, and allowed to settle. If the previous work has been well done, the settlement will be uniform; if it is done late in autumn, the ground will become none too firm during the winter, and it should not be deeply plowed, but harrowed and leveled as early in spring as it can be worked. If good sod can be procured, the court will be ready for use as soon as the grass is green. The sods, of equal thickness, should be rolled down very firmly, to bring the grass roots in close contact with the soil. It is a good plan to sow the seed of Kentucky blue grass and the finer varieties of red top upon the sod as it is laid, and to repeat this sowing every spring. A dressing of some "complete" fertilizer—that is, one that contains nitrogen, potash, and phosphoric acid—can also be applied every spring; or fine manure can be spread over the lawn in autumn, to be raked off in spring. In case no sod can be procured, the seeds of the grasses above named can be sown after the ground is leveled and roiled, then lightly raked in and rolled again. If the seeding is done in early spring, the court can be used the same summer; but no seeded lawn is at its best the first season after sowing. Seed can be sown in early September, if the preparation of the soil has been made several weeks before, so as to allow time for settling.

No pains or expense should be spared to obtain the purest and freshest seed, which can best be done by applying to reputable dealers, who have sufficient call for it to warrant them in keeping it. Much disappointment has come from using inferior seed.—*Garden and Forest.*

[THE MEDICAL RECORD.]

NOTES ON THE GERMICIDAL ACTION OF PEROXIDE OF HYDROGEN.*

By H. GIFFORD, M.D., Omaha, Neb., Ophthalmic and Aural Surgeon to the B. & M. R.R.

IN spite of the extensive use of peroxide of hydrogen and the commonly received opinion as to its value as a germicide, its germ-killing power has not, so far as I can learn, been investigated thoroughly. The prevalent impression of its value probably rests largely on the experiments of Kingzett, Guttmann, and Miguel; but these, which were not conducted with the improved methods of bacteriology, prove nothing as to its germicidal power, but simply that in certain small proportions it prevents the development of some microbes (species not determined). Wecks,† using modern methods, found, devoting a short paragraph to the subject, that the "hydrogen dioxide, formula HO_2" [*sic*] destroyed pyogenic germs in exposures of one to one and one-half minutes. He gives no idea, however, of the strength of the solution used, and the impression given by him of the extreme instability of the compound requires some correction. I have therefore thought it worth while to test the substance in various strengths on the bacilli and spores of anthrax and on the white and yellow pus cocci.

The article used was Charles Marchand's fifteen-volume solution. The methods were: 1, that of Koch, in which threads, impregnated with the germs, are subjected to the influence of the germicide, and then, after washing in sterilized water, placed on the surface of the nutrient medium; 2, the following plan, which is somewhat simpler and more expeditious: A small platinum loopful of the germs is rubbed up rapidly in the germicidal liquid; from this emulsion a loopful, containing many hundred germs, is, after the desired length of exposure, transferred to a test tube, containing melted agar or gelatine, in which it is thoroughly shaken up. The tube is then placed in the incubator in a nearly horizontal position, and if any germs are left alive, they develop, scattered through the mass. This method has the advantage, without the bother, of plate cultures, or even of Esmarch's roll cultures, of giving an approximate idea of the proportion of germs that survive a given exposure. The method is open to the theoretical objection that the minute amount of the germicide introduced into the culture medium might prevent the growth of germs not really killed, but the weight of this objection is easily removed by a few control-experiments. Since completing my work I notice that Martens‡ has used a similar plan, and doubtless it has been used by many others, though I have not seen it mentioned.

It was found that the fresh fifteen-volume solution killed the white and yellow cocci and the anthrax bacilli

* Read before the Omaha Medical Club, July 18, 1888.

† Archives of Ophthalmology, xvi., 4.

‡ Virchow's Archiv, cxii., 2.

in exposures of three-quarters to one and one-half minutes, and fully developed anthrax spores in three to four minutes. When the second method was employed, with Koch's threads, the results were more inconstant, and the average time required for killing was somewhat longer (*i. e.*, three to five minutes for anthrax spores and one to two and one-half minutes for the cocci and bacilli). This was probably because, in the dried clumps on the threads, some of the germs were shielded from the action of the peroxide. Also, when mixed with blood and pus (*i. e.*, under approximately natural conditions), the pus germs were killed in one to two minutes.

To eliminate the possibility that these results were due to the free acid which the stable solutions of the peroxide contain, a gravimetric analysis of a sample was kindly made for me by Mr. Bruce, of the Union Pacific Laboratory, showing the presence of 0·118 per cent. of free HCl. This result differs considerably from the statement, in the announcement of Marchand's solution, that the latter contains but "$\frac{1}{1000}$ phosphoric acid and $\frac{1}{4000}$ sulphuric acid," still the proportion is too insignificant to account for the results achieved. A full strength neutral or alkaline solution is difficult to obtain, as the H_2O_2 decomposes very rapidly on the addition of the alkali (sodium bicarbonate), even when it is kept at low temperature by the aid of ice, during the neutralization; but a slightly alkaline mixture formed by the addition of a drop of a saturated solution of sodium carbonate to twenty drops of the peroxide solution is actively germicidal.

The statement of Weeks, therefore, applies correctly to the fresh fifteen-volume solution, but his report of the instability of the solution used by him would lead one to infer that exposing it to ordinary room temperature for a few hours, to say nothing of days, would certainly destroy all valuable germicidal power. I found, however, that a solution exposed for forty days to a temperature of 68° to 75° F., in an ordinarily corked flask, still killed the yellow pus cocci in ten to eleven minutes.

While, however, the enthusiasm with which the peroxide has generally been received as a germicide can be considered justified if the fresh fifteen-volume solution is referred to, the same cannot be said of some of the dilutions recommended. The instructions accompanying the Marchand solution advise diluting with about four times its bulk of water, for use on "mucous membranes as injections, etc." A dilution of this strength was found not to have killed the pus cocci after an exposure of thirty minutes—a result which practically bars it as a germicide, though for its cleansing action it may still be valuable, especially when combined with another antiseptic, as has been recommended by Dr. Macrae, of Council Bluffs.* The fresh solution, diluted with an equal volume of water, killed the pus germs after a three to four minutes' exposure; diluted with twice its bulk of water, it destroyed all but a minute fraction of the germs, after an exposure of ten minutes.

The fifteen-volume solution is sharply irritating to the conjunctiva and nasal mucous membrane, and even the weakest solution mentioned in the announcement (two to three volumes), instead of being "bland as water," causes considerable smarting of the eyes and nose for a few minutes.

Regarding the mode in which the peroxide acts, the common impression, fostered by alleged observations, that the bacteria and pus globules are rent asunder, and reduced to a mass of debris by the violence of the decomposition, is erroneous. After an exposure of an hour, all active ebullition having ceased, I have failed to observe any appreciable change in the appearance of anthrax spores and bacilli, though they were killed dead as stones; and pus globules, after many hours' exposure, though changed in appearance, still retain their contour. Neither is it, in my opinion, the nascent oxygen which kills the germs. Formerly, in common with many others, I believed that it did, and would watch with glee the mass of bubbles resulting from an instillation of the peroxide into a suppurating ear, considering each bubble the signal of the death of many micrococci. As a matter of fact, however, a partly decomposed alkaline solution, which foams much more furiously (*i. e.*, gives out nascent oxygen more rapidly) than a fresh slightly acid solution, is much less efficient than the latter. The germs, apparently, are not killed by the ozone liberated, but are simply poisoned by the undecomposed peroxide, just as they are by carbolic acid and sublimate. In other words, while the ebullition, by its mechanical effects, is what makes the peroxide valuable as a cleanser, when it comes to germ killing, with a solution of a given strength, the less bubbling the better, except in so far as it favors the access of undecomposed peroxide to germs protected by secretions.

[Since reading the above paper, I have first noticed the work of Van Hettinga Tromp (Ref. in "Centralblatt fur Bacteriologie," III., 35), who finds that H_2O_2 in the proportion of $\frac{1}{15000}$ kills anthrax spores in twenty-four hours, typhus bacilli in five minutes, and that cholera bacilli are killed in less than five minutes by $\frac{1}{10000}$. Unless typhus and cholera bacilli are especially susceptible, these results would indicate a greater germicidal power than I have found, as a fifteen-volume solution is supposed to contain something more than three per cent. of the peroxide; but without knowing just what preparation Van Tromp used, a profitable comparison of our results can hardly be made.]

* Omaha Clinic, i., 3.

THE CONTAMINATING WELL.

THE *Sanitary News* truthfully says that undoubtedly the well on the farm is a source from which comes many diseases. Some wells are never cleaned. When dug they are carefully boarded over, the pumps made tight and snug, with the ground sloping away on all sides, so as to allow the surface water to flow from the opening. There is no well water that is pure. Something depends on the character of the soil. If sandy, and the water will quickly disappear from the surface after a rain, the well will drain the soil for a long distance around it, and the consequence will be that a large portion of the soluble filth of the soil will find its way into the well, although the water may appear sparkling and bright. It is contended that the soil removes all the impurities from the water; but this depends upon whether the soil, by long continued absorbtion, be not already so thoroughly saturated with impurities as to refuse to take up more. That the soil does not remove all the impurities, even from new ground where a well has been recently dug, has been demonstrated by saturating the surface earth at a distance from the well with kerosene oil, which gradually found its way to the well (having been washed down by the rains) and imparted its odor to the water. If the soil be of heavy clay the danger will be lessened, but on all porous soil the liability of pollution of the water is great. No manure heaps, privies, sinks, or other receptacle for filth or refuse of any kind should be within one hundred and fifty feet of the well; the further off, the better. No matter how tight the well may be, the toad will sometimes continue to get in. Many wells contain toads that die and are swallowed in the drinking water unknowingly, under the supposition that the well is tight and "toad proof." Wells should be thoroughly cleaned at least once a year, and especially in the fall. For a distance of ten feet around the well the surface should be cemented, and the pump itself should be cleaned occasionally. Toads, flies, bugs, worms, and even gnats will get in the water, while only a few drops of a solution from a filthy drain or sink, finding its way into the well, will carry bacteria enough to rapidly multiply and contaminate all of the water. Roots of trees and vines also serve as drains into the wells, as they loosen the soil, and for that reason they should never be planted near the source of drinking water.

NICKEL.—There is said to be but one nickel mine in the United States which is extensively worked. This mine is in Lancaster Co., Pa. It has been worked for over twenty years, and developed to a depth of nearly 300 feet. The length of the lode is about 25,000 feet, and it produces about 500 tons per month, employing in its work about 200 men.

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